THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

(UNIVERSITY OF LONDON)

INCLUDING

THE ROYAL COLLEGE OF SCIENCE
THE ROYAL SCHOOL OF MINES
THE CITY AND GUILDS COLLEGE

CALENDAR

SESSION 1952—53

THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

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DATES OF TERMS

Session 1952-53

Autumn Term : Tuesday, 7th October, 1952, to Thursday, 18th December, 1952.

Spring Term : Tuesday, 13th January, 1953, to Friday, 27th March, 1953.

Summer Term : Tuesday, 28th April, 1953, to Friday, 26th June, 1953.

First Half-Session ends : Friday, 6th February, 1953.

Second Half-Session begins : Monday, 9th February, 1953.

All communications on the educational work of the Royal College of Science or the Royal School of Mines should be addressed to the Registrar, Imperial College, Prince Consort Road, London, S.W.7, and on that of the City and Guilds College to the Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7.

Telephone (all Departments) : KENsington 4861.

(*All announcements in the Calendar and Prospectus are subject to modification or cancellation.*)

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

ORIGIN AND OBJECTS

The Imperial College of Science and Technology, commonly known as **The Imperial College,** was established by Royal Charter in 1907, and includes as constituent Colleges the following three previously existing institutions—

The Royal College of Science,
The Royal School of Mines,
The City and Guilds College.

The purposes of the Imperial College are "to give the highest specialised instruction, and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry."

HISTORICAL NOTE

The Royal College of Science and the Royal School of Mines had their origin in the Royal College of Chemistry, Hanover Square (founded in 1845), and the Government School of Mines and of Science Applied to the Arts, Jermyn Street (founded in 1851). The former institution was incorporated in the latter in 1853. The title of the Metropolitan School of Science Applied to Mines and of the Arts. In 1857 this title was changed back to the Government School of Mines and of Science Applied to the Arts, and again in 1863 to the Royal School of Mines. In 1881 the pure science departments of the Royal School of Mines, which had been transferred to South Kensington (mostly in 1872), were organised separately under the title of the Normal School of Science, which in 1890 was changed, retrospectively, to the Royal College of Science. In 1891 the departments of the Royal School of Mines itself had been transferred from Jermyn Street, and since that date all departments of the two Colleges have been located in South Kensington.

The City and Guilds College was originally the Central Institution of the City and Guilds of London Institute. It was opened in 1885 at South Kensington. Its title was changed to the Central Technical College in 1893, and to the City and Guilds College in 1907.

Since 1891, therefore, there have been three Colleges at South Kensington devoted to various branches of pure and applied science. It was by the federation of these three Colleges in 1907 that the Imperial College of Science and Technology was formed.

The Imperial College has been a School of the University of London since 1908.

BUILDINGS

The buildings of the Imperial College are situated mainly in South Kensington, most of them lying between Exhibition Road and Queen's Gate. Their designations are as follows :—

ADMINISTRATION BLOCK : Prince Consort Road, N. side :—

BEIT BUILDING :
Administrative Offices of the Imperial College.
Imperial College Hostel.
IMPERIAL COLLEGE UNION BUILDING.
BOTANY AND ZOOLOGY BUILDINGS.
ROYAL COLLEGE OF SCIENCE MAIN BUILDING : Imperial Institute Road, S. side. — ROYAL COLLEGE OF SCIENCE.
HUXLEY BUILDING, Exhibition Road, E. side
R.S.M. AND C. & G. BLOCK : Prince Consort Road, S. side, and Exhibition Road, W. side :—

ROYAL SCHOOL OF MINES BUILDING. — ROYAL SCHOOL OF MINES.

CITY AND GUILDS COLLEGE MAIN BUILDING.
GOLDSMITHS' EXTENSION OF THE CITY AND GUILDS COLLEGE.
UNWIN BUILDING. — CITY AND GUILDS COLLEGE.
CHEMICAL ENGINEERING BUILDING : Prince Consort Road, S. side.

The Lecture Rooms, Laboratories, Workshops, Drawing Offices, etc., of the various Departments of the College are housed in these buildings. In addition to the buildings at South Kensington, the College maintains a Field Station at Silwood Park, Sunninghill, Berks., and the Tywarnhaile Mine, Mt. Hawke, Truro, Cornwall.

ADMINISTRATION

The Administration of the Imperial College is vested in a Governing Body consisting of fifty-two members (*see* p. 8) representing the Crown, the self-governing Countries of the Commonwealth, the Ministry of Education, the University of London, the London County Council, the City and Guilds of London Institute, the Royal Commissioners for the Exhibition of 1851, the Royal Society, the Teaching Staff of the Imperial College, and learned societies concerned with industries. The Rector and the three Deans are *ex-officio* members.

The Governing Body is assisted in its work by Finance and Executive Committees, a Board of Studies (*see* p. 13) and various Special Committees (*see* p. 14).

Whereas the Royal College of Science and the Royal School of Mines are under the direct administrative control of the Governing Body of the Imperial College, the City and Guilds College is administered by a Delegacy (*see* p. 12) of the Imperial College and the City and Guilds of London Institute (*see* p. 10) with representatives

of the Worshipful Company of Goldsmiths and the Worshipful Company of Clothworkers. The Dean of the City and Guilds College is the chief officer of the Delegacy.

The Delegacy of the City and Guilds College is assisted in its work by a Finance Committee and an Engineering Board (*see* p. 13).

THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

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Lecturers.—P. T. Fink, B.E. ; F. G. Irving, M.Eng., D.I.C. ; S. Kelsey, B.Sc.(Eng.). (*Two vacancies*).

Demonstrator.—J. L. Stollery, B.Sc.(Eng.), A.C.G.I.

Laboratory Superintendent.—W. H. Davies.

BOTANY

Professor of Plant Pathology and Head of the Department.—†W. Brown, M.A., D.Sc., D.I.C., F.R.S.

Professor of Plant Physiology.—†F. G. Gregory, D.Sc., A.R.C.S., D.I.C., F.R.S.

Assistant Director of Botanical Laboratories and Senior Lecturer (Cytology and Genetics).—*F. Howarth, B.Sc., A.R.C.S., F.L.S.

Reader in Biochemistry.—†H. W. Buston, D.Sc., A.R.C.S., D.I.C.

Reader in Bacteriology.—†S. E. Jacobs, D.Sc., Ph.D., A.R.C.S.

Lecturers : General Botany.—*Miss C. A. Pratt, M.A., Ph.D., D.I.C., F.L.S. ; *Ecology.*—*A. J. Rutter, Ph.D., A.R.C.S. ; *Plant Pathology.*—R. K. S. Wood, Ph.D., A.R.C.S. ; *Timber Technology.*—J. F. Levy, B.Sc., A.R.C.S. ; *Bacteriology.*—Miss M. S. Lacey, D.Sc. ; *Plant Physiology.*—D. C. Spanner, Ph.D., A.R.C.S. ; *Biochemistry.*—J. Russell, Ph.D., B.Sc.

Special Lecturer : Plant Physiology.—*O. V. S. Heath, D.Sc., Ph.D., A.R.C.S., D.I.C.

Assistant Lecturers.—Miss S. Mount, B.Sc., Miss K. Stedman, B.Sc., A.R.C.S.

Assistant Lecturer (Research Assistant).—Miss M. J. Smieton, B.Sc.

Demonstrator.—M. F. Madelin, B.Sc., A.R.C.S.

Laboratory Superintendent.—H. Tooley.

Research Institute of Plant Physiology

Director.—†Professor F. G. Gregory, D.Sc., A.R.C.S., D.I.C., F.R.S.

† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

Research Staff.—*B. D. Bolas, D.Sc., D.I.C. ; F. J. Richards, B.Sc. ; Mrs. H. K. Porter, D.Sc. ; Miss O. N. Purvis, Ph.D. ; *O. V. S. Heath, D.Sc., Ph.D., A.R.C.S., D.I.C. ; E. S. J. Hatcher, Ph.D. ; W. W. Schwabe, Ph.D., A.R.C.S. ; C. L. Mer, Ph.D., A.R.C.S. ; C. R. Hancock, B.Sc. ; F. W. M. Llewelyn, B.Sc., A.R.C.S.

CHEMISTRY

Inorganic and Physical Chemistry

Professor of Inorganic Chemistry and Director of the Laboratories for Inorganic and Physical Chemistry.—†H. V. A. Briscoe, D.Sc., A.R.C.S., D.I.C., F.R.I.C.

Assistant Director.—*A. A. Eldridge, B.Sc., F.R.I.C.

Readers : Analytical Chemistry.—†L. S. Theobald, M.Sc., A.R.C.S., F.R.I.C. ; *Physical Chemistry.*—†F. C. Tompkins, D.Sc., Ph.D. ; *Inorganic Chemistry.*—†A. J. E. Welch, Ph.D., A.R.C.S., D.I.C.

Senior Lecturers : Inorganic Chemistry and Chemistry and Microscopy of Food and Drugs.—*A. A. Eldridge, B.Sc., F.R.I.C.; *Agricultural Chemistry.*—*A. G. Pollard, B.Sc., A.R.C.S., D.I.C., F.R.I.C.

Lecturers : Inorganic Chemistry.—*P. C. Bull, D.S.O., A.R.C.S., A.R.I.C.; *Physical Chemistry.*—*J. A. Kitchener, Ph.D. ; *Inorganic Chemistry.*—*E. R. Roberts, Ph.D., A.R.C.S., D.I.C. ; Miss M. Carlton, Ph.D. ; *Agricultural Chemistry and Microscopy of Food and Drugs*—J. T. Hannen, M.A., A.R.C.S. ; *Physical Chemistry.*—J. O'M. Bockris, D.Sc., A.R.I.C. ; *Inorganic Chemistry.*—J. F. Herringshaw, Ph.D., A.R.C.S., D.I.C., A.R.I.C. ; *Physical Chemistry.*—B. Atkinson, Ph.D., A.R.C.S., D.I.C. ; C. F. Cullis, M.A., B.Sc., D.Phil. ; *Agricultural Chemistry.*—A. H. Cornfield, Ph.D., A.R.C.S., D.I.C. ; *Inorganic Chemistry.*—I. David, Ph.D., A.R.C.S.; *Physical Chemistry.*—G. J. Hills, Ph.D., B.Sc., A.R.I.C.; *Analytical Chemistry.*—J. A. W. Dalziel, B.Sc., A.R.C.S.; *Physical Chemistry.*—P. W. M. Jacobs, M.Sc., Ph.D.

Laboratory Superintendent.—F. W. L. Croker.

Organic Chemistry

Professor and Director of the Laboratories.—†R. P. Linstead, C.B.E., M.A.(Harvard), Ph.D., D.Sc., A.R.C.S., F.R.I.C., F.R.S.

Assistant Director.—*A. A. Eldridge, B.Sc., F.R.I.C.

Reader.—Vacant.

Senior Lecturer.—*L. N. Owen, D.Sc., Ph.D., F.R.I.C.

Lecturers.—*E. A. R. Braude, D.Sc., Ph.D., A.R.C.S., D.I.C., F.R.I.C. ; B. C. L. Weedon, Ph.D., A.R.C.S., D.I.C. ; J. A. Elvidge, Ph.D., A.R.C.S., D.I.C., L. Crombie, Ph.D.

Honorary Lecturer.—Miss F. M. Hamer, Sc.D., D.Sc., F.R.I.C.

† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

Assistant Lecturers.—C. J. Timmons, Ph.D., A.R.C.S.; Miss M. Whalley, B.Sc., Ph.D., A.R.I.C.; L. M. Jackman, B.Sc., †M.Sc., Ph.D. (Adelaide).

Laboratory Superintendent.—R. H. Young.

ENGINEERING, CHEMICAL AND APPLIED CHEMISTRY

Professor of Chemical Technology and Head of the Department.—*Vacant.*

Professor of Applied Physical Chemistry.—Vacant.

Courtaulds Professor of Chemical Engineering.—†D. M. Newitt, M.C., D.Sc., Ph.D., A.R.C.S., D.I.C., M.I.Chem.E., F.R.S.

Reader : Fuel Technology.—†G. W. Himus, Ph.D., A.R.C.S., D.I.C., F.G.S., F.Inst.F.

Senior Lecturer : Chemical Engineering.—*J. M. Coulson, M.A., Ph.D., D.I.C., A.M.I.Chem.E.

Lecturers : Chemical Engineering.—J. F. Richardson, Ph.D., A.C.G.I., A.M.I.Chem.E. ; G. H. Anderson, B.Sc. ; K. E. Weale, Ph.D. ; *Refractory Materials.*—L. R. Barrett, M.A., B.Sc., M.S., A.R.I.C., M.Inst.F. ; *Applied Physical Chemistry.*—H. Wilman, D.Sc., Ph.D., A.R.C.S., D.I.C., F.Inst.P. ; *Combustion.*—*J. H. Burgoyne, D.Sc., Ph.D., A.R.C.S., D.I.C., F.R.I.C. ; *Chemical Thermodynamics.*—R. F. Strickland-Constable, M.A., D.Phil. ; *Low Temperature Technology.*—G. G. Haselden, Ph.D., A.C.G.I., A.M.I.Chem.E. ; G. J. Minkoff, Ph.D., D.I.C.

Special Lecturer : Blast Furnace Technology.—H. L. Saunders, Ph.D., F.R.I.C.

Assistant Lecturer.—K. E. Bett, B.Sc.

Assistant Lecturer : Electron-Microscopy.—M. M. Bluhm, B.Sc.

Demonstrator.—K. W. Glover, B.Sc., A.C.G.I.

Laboratory and Workshop Superintendents.—A. C. V. Sweeting and E. S. Brett.

Note.—The main subjects of the Undergraduate Course in Chemical Engineering up to the end of the Second Year are taken in the Department of Mechanical Engineering (Head of the Department, Professor O. A. Saunders, M.A., D.Sc.(Eng.), M.I.Mech.E.) and in the Department of Inorganic and Physical Chemistry (Head of the Department, Professor H. V. A. Briscoe, D.Sc., A.R.C.S., D.I.C., F.R.I.C.).

ENGINEERING, CIVIL

Professor and Head of the Department.—†A. J. S. Pippard, M.B.E., D.Sc., M.I.C.E., F.R.Ae.S., Hon.A.C.G.I.

Professor of Concrete Technology.—†A. L. L. Baker, B.Tech., M.I.C.E., Hon.A.C.G.I.

Professor of Fluid Mechanics and Hydraulic Engineering.—†C. M. White D.Sc.(Eng.), Ph.D., Hon.A.C.G.I.

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† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

Readers.—†B. G. Manton, B.Sc.(Eng.), D.I.C., A.M.I.C.E. ; †A. W. Skempton, D.Sc.(Eng.), A.C.G.I., D.I.C., A.M.I.C.E. ; †S. R. Sparkes, Ph.D., M.Sc., D.I.C., A.M.I.C.E. ; †A. Stephenson, O.B.E., M.A., F.R.I.C.S.

Special Lecturers : Applied Fluid Mechanics and Hydraulic Structures.—C. Jaeger, Dr.ès.Sc. ; *Hydraulic Machinery.*—J. M. Gray, B.Sc.

Rockefeller Fellow in Public Health Engineering.—F. E. Bruce, M.Sc.(Eng.), S.M.(Harvard), A.C.G.I., D.I.C., A.M.I.C.E.

Lecturers.—*R. J. Ashby, M.Sc.(Eng.), A.C.G.I., D.I.C., A.M.I.C.E. ; J. E. Duncan, B.Sc.(Eng.), A.M.I.C.E. ; *J. R. D. Francis, B.Sc.(Eng.) ; H. Ainsworth, M.A., A.R.I.C.S. ; *A. W. Bishop, M.A., A.M.I.C.E. ; J. C. de C. Henderson, D.I.C., A.R.I.B.A. ; P. O. Wolf, B.Sc.(Eng.), A.M.I.C.E., A.M.I.W.E. ; D. J. Henkel, B.Sc.(Eng.) ; E. H. Brown, B.Sc.(Eng.); Z. S. Makowski, Dip. Eng.; A. H. Matlock, M.Sc.

Lecturer (Research Assistant).—Miss L. Chitty, M.A., D.I.C., F.R.Ae.S., A.M.I.C.E.

Assistant Lecturers.—D. H. Kent, B.A. ; A. C. Cassell, B.Sc.(Eng.).

Laboratory Superintendent.—A. Amos.

ENGINEERING, ELECTRICAL

Professor and Head of the Department.—†Willis Jackson, D.Sc., D.Phil., M.I.E.E., F.Inst.P., Hon.A.C.G.I.

Readers : Electrical Engineering.—†B. Adkins, M.A., M.I.E.E. ; *Mullard Reader in Electronics.*—†D. Gabor, D.Ing., M.I.E.E. ; *Henry Mark Pease Reader in Telecommunications.*—†E. C. Cherry, D.Sc.(Eng.), A.M.I.E.E.

Senior Lecturers : Measurements.—*C. R. Urwin, A.C.G.I., A.M.I.E.E. ; *Electrical Machines.*—*D. W. Hopkin, M.I.E.E. ; *M. W. Humphrey Davies, M.Sc., A.M.I.E.E. ; *Electrical Communications.*—*D. M. Tombs, M.Sc.(Eng.)., A.C.G.I., D.I.C., A.M.I.E.E.

Lecturers.—A. R. Boothroyd, B.Sc., Ph.D., D.I.C. ; J. Brown, M.A. ; E. H. T. Jackson, D.F.H., A.M.I.E.E. ; H. Kayser, M.Sc. ; *J. Lamb, M.Sc., Ph.D. ; H. E. Park, A.M.I.E.E. ; B. J. Prigmore, M.A., M.Sc., D.I.C., A.M.I.E.E. ; D. Rutenberg, B.Sc. ; G. R. Slemon, M.A., B.Sc. ; J. H. Westcott, B.Sc., Ph.D., D.I.C.

Special Lecturers.—J. R. Mortlock, Ph.D., M.I.E.E. ; J. A. Saxton, Ph.D., A.M.I.E.E. ; H. Page, M.Sc., A.M.I.E.E.

Assistant Lecturers.—*(two vacancies).*

Laboratory and Workshop Superintendents.—G. W. Chilton, A.M.I.E.C., C. C. Mills.

ENGINEERING, MECHANICAL

Professor and Head of the Department.—†O. A. Saunders, M.A., D.Sc. (Eng.), M.I.Mech.E., F.Inst.P.

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† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

Professor of Applied Mechanics.—†H. Ford, D.Sc.(Eng.), Ph.D., A.C.G.I., Wh.Sch., M.I.Mech.E.

Readers : Mechanical Engineering.—†H. Heywood, D.Sc.(Eng.), Ph.D., A.C.G.I., Wh.Sch., M.I.Mech.E. ; †E. Glaister, Ph.D., M.Sc., A.C.G.I., D.I.C., A.M.I.Mech.E. ; *Applied Heat.*—†Mrs. M. Fishenden, D.Sc., F.Inst.P. ; *Gas Turbines.*—†A. G. Smith, B.Sc.

Senior Lecturers.—*F. Dyson, B.Sc.(Eng.), A.C.G.I., A.M.I.Mech.E. ; *W. Collins, B.Sc.(Eng.), A.C.G.I., A.M.I.Mech.E. ; G. M. Cawley, A.M.I.Mech.E. ; *J. W. James, Ph.D., D.I.C., A.C.G.I.

Lecturers and Instructors in Engineering Design and Applied Mechanics.—*E. H. Lewitt, Ph.D., A.M.I.Mech.E. ; T. L. Treharne, B.Sc.(Eng.), A.C.G.I., Wh.Sch., A.M.I.Mech.E. ; R. D. Hoyle, B.A., A.M.I.Mech.E. ; A. E. Beal, A.R.C.S. ; J. T. Chalk, M.Sc., D.I.C., Wh.Sch., A.M.I.C.E., M.Inst.Struct.E. ; N. P. W. Moore, B.Sc.(Eng.), A.C.G.I., A.M.Inst.F. ; P. Grootenhuis, D.I.C., B.Sc.(Eng.), A.C.G.I., A.F.R.Ae.S. ; E. H. Cole, B.Sc.(Eng.), A.C.G.I., Wh.Sch., A.M.I.Mech.E. ; R. D. Tyler, B.Sc.(Eng.). ; J. A. Dallender, B.Sc.(Eng.), A.C.G.I.

Assistant Lecturers.—D. R. Bland, M.A. ; S. J. Peerless, B.Sc.(Eng.), A.C.G.I. ; C. E. Turner, B.Sc.(Eng.) ; F. Ellis, B.Sc., A.C.G.I.

Draughtsman and Drawing Office Assistant.—T. McVey.

Laboratory and Workshop Superintendent.—R. W. Dubbins.

Workshop Assistants and Instructors.—F. Hallard, E. H. Kemp, D. Tait, H. J. Ramsay.

Boiler Room Superintendent.—S. R. Rowe, M.I.E.C.

GEOLOGY

including Mining Geology and Oil Technology

Professor of Mining Geology (*also in charge of Administration of Geology Department*).—†D. Williams, D.Sc., Ph.D., B.Eng., D.I.C., M.I.M.M., F.G.S.

Professor of Geology (*also in charge of Direction of Geological Research*).—†H. H. Read, D.Sc., A.R.C.S., F.R.S.E., F.R.S.

Professor of Geology (*Oil Technology*).—†V. C. Illing, M.A., M.I.M.M., M.Inst.P.T., Hon.A.R.S.M., F.R.S.

Reader in Structural Geology—†Gilbert Wilson, M.Sc., Ph.D., D.I.C., F.G.S.

Senior Lecturer : Engineering Geology.—*F. G. H. Blyth, Ph.D., M.Sc., A.C.G.I., D.I.C., F.G.S.

Lecturers : Oil Technology.—S. E. Coomber, B.Sc., A.R.S.M. ; *G. D. Hobson, Ph.D., A.R.S.M., D.I.C. ; *Petrology.*—J. Sutton, Ph.D., A.R.C.S., F.G.S. ; W. S. Pitcher, Ph.D., B.Sc., F.G.S. ; D. J. Shearman, B.Sc., F.G.S. ; *Mineralogy.*—*F. Jones, T.D., M.Sc., Ph.D., F.G.S. ; *Mining Geology.*—J. S. Webb, Ph.D., A.R.S.M., D.I.C. ; A. P. Millman, B.Sc., A.R.S.M. ; *Palæontology.*—D. J. Carter, D.F.C., B.Sc., A.R.C.S. ; G. Thomas, Ph.D., B.Sc., F.G.S.

† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

Assistant Lecturers.—C. A. Fothergill, B.Sc., A.R.S.M. (*part-time*) ; G. P. L. Walker, M.Sc., B.Sc., D. V. Ager, B.Sc.

Demonstrator.—One vacancy.

Librarian and Assistant Lecturer.—R. L. Cheesman, M.Sc., D.I.C., F.G.S.

Laboratory Superintendent.—E. J. Hill.

MATHEMATICS

Professor and Head of the Department.—†H. Levy, M.A., D.Sc., Hon.A.R.C.S., F.R.S.E.

Professors.—†W. G. Bickley, D.Sc., F.R.Ae.S. ; †H. Jones, F.R.S., Ph.D., Hon.A.R.C.S.

Reader.—†C. H. Kebby, M.Sc., A.R.C.S.

Readers in Applied Mathematics.—†D. N. de G. Allen, M.A. ; †G. J. Whitrow, M.A., D.Phil..

Reader in Mathematical Statistics.—†G. A. Barnard, M.A.

Reader in Pure Mathematics.—†L. Roth, M.A.

Senior Lecturer.—A. J. Hatley, M.A.

Lecturers.—E. E. Preidel, M.Sc., A.R.C.S., D.I.C. ; E. H. Lloyd, Ph.D., A.R.C.S., D.I.C. ; A. Talbot, M.A., Ph.D. ; A. J. Mautner, B.Sc., A.F.R.Ae.S. ; *S. Rushton, M.A., Ph.D., B.Sc., D.I.C. ; *K. D. Tocher, Ph.D., B.Sc.; W. A. Hepner, Ph.D.; A. N. Gordon, M.Sc., Ph.D. ; E. P. Wohlfarth, Ph.D., B.Sc. ; H. Fairbrother, M.Sc. ; S. Michaelson, B.Sc., A.R.C.S. ; M. A. Jaswon, M.A., Ph.D. ; *Miss R. C. H. Young, Ph.D. ; S. Raimes, Ph.D., B.Sc., A.R.C.S.; E. H. Sondheimer, M.A., Ph.D.; R. S. H. G. Thompson, B.Sc.

Assistant Lecturers.—Miss E. D. Lang, M.A.; W. J. Lucas, B.Sc., A.R.C.S.; Miss F. Moshkowitz, M.Sc., A.R.C.S., D.I.C. ; R. T. Severn, B.Sc., A.R.C.S.

Professor's Assistant.—E. A. Nehan.

METALLURGY

Professor and Head of the Department.—†C. W. Dannatt, A.R.S.M., D.I.C., F.R.I.C.

Readers.—†M. S. Fisher, D.Sc., Ph.D.; †E. W. Yeoman, M.Sc., A.R.S.M., A.R.C.S., D.I.C., F.R.I.C.

Nuffield Research Fellow.—F. D. Richardson, Ph.D.

Lecturers.—G. L. Evans, B.Sc., M.Sc., D.I.C.; R. H. Harris, B.Sc.(Eng.), A.R.S.M.; E. Phillips, B.Sc., M.Sc., D.I.C. ; F. L. Selfe, F.R.I.C.; D. L. Thomas, B.Sc. ; J. G. Tweeddale, A.M.I.Mech.E. ; D. R. F. West, Ph.D., D.I.C.; D. A. Pantony, Ph.D., B.Sc., A.R.I.C.

Assistant Lecturer.—Vacant.

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* Recognised Teacher of the University of London.

METEOROLOGY

Professor and Head of the Department.—†P. A. Sheppard, B.Sc., F.Inst.P.

Reader : Physical Climatology.—†E. T. Eady, B.A., Ph.D.

Lecturers.—B. J. Mason, M.Sc. ; R. S. Scorer, M.A., Ph.D. ; F. H. Ludlam, D.I.C.

Laboratory and Workshop Supervisor.—E. G. Jennings.

MINING

Professor and Head of the Department.—*Vacant.*

Reader in Mine Surveying.—†J. S. Sheppard, O.B.E., B.Sc.(Eng.), A.R.S.M., A.M.I.M.M.

Reader in Mineral Dressing.—†E. J. Pryor, A.R.S.M., D.I.C., M.I.M.M.

Senior Lecturers.—*W. Davies, B.Sc., Ph.D., A.M.I.Mech.E. ; M. G. Fleming, Ph.D., B.Sc., M.I.M.M., M.A.I.M.E.

Lecturers.—*J. B. Richardson, A.R.S.M., M.I.M.M. ; T. L. Thomas, M.B.E., Ph.D., B.Sc. ; H. Jennings, B.Sc., A.C.G.I. ; H. N. Blyth, B.A., F.R.I.C., A.I.M. ; A. R. Burkin, Ph.D., B.Sc.; A. Grierson, B.Sc.(Eng.).

Assistant Lecturer.—A. J. Robinson, B.Sc.(Eng.), A.R.S.M.

Drawing Office Assistant to the Professor.—B. Parker.

Laboratory Superintendent.—W. E. Blunt, Affiliate I.M.M.

Field Assistants in Surveying and Mine Surveying.—C. J. R. Turner ; T. Shanly.

PHYSICS

including Astrophysics, Technical Optics, and Applied Geophysics

Professor, Head of the Department and Director of the Laboratories.—*Vacant.*

Professor of Technical Optics.—†W. D. Wright, D.Sc., A.R.C.S., D.I.C.

Professor of Physics.—†S. Devons, M.A., Ph.D.

Readers.—†R. W. B. Pearse, D.Sc., Ph.D., A.R.C.S., D.I.C. ; †C. E. Wynn-Williams, D.Sc., Ph.D. ; †J. McG. Bruckshaw, M.Sc., Ph.D., D.I.C. ; †M. Blackman, M.Sc., Ph.D., D.I.C. ; †O. Klemperer, Ph.D. ; †B. K. Johnson, D.I.C.

Honorary Lecturer.—W. Jevons, D.Sc., A.R.C.S., D.I.C.

Senior Lecturers.—*R. W. B. Stephens, Ph.D., A.R.C.S., D.I.C.

Lecturers.—W. R. S. Garton, B.Sc., A.R.C.S. ; Mrs. C. Kellner, Ph.D. ; J. L. Michiels, Ph.D., A.R.C.S.; J. Aharoni, Ph.D. ; R. G. Mason, M.Sc., A.R.C.S., D.I.C. ; H. R. Allan, M.A., Ph.D. ; N. C. Barford, B.A., B.Sc. ; R. Latham, M.A., Ph.D. ; H. H. Hopkins, B.Sc., Ph.D. ; B. R. Coles, D.Phil., B.Sc. ; W. Weinstein, B.Sc. ; M. J. Pentz, B.Sc.(Eng.), M.Sc.; E. P. George, Ph.D., A.M.I.E.E.

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† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

Assistant Lecturers.—Mrs. H. L. Brock, B.Sc. ; A. F. Moore, B.A.

Demonstrator.—S. H. Hall, B.Sc., M.Sc.

Laboratory Superintendent.—W. Thompson.

ZOOLOGY AND APPLIED ENTOMOLOGY

Professor and Head of the Department.—†J. W. Munro, C.B.E., M.A., D.Sc., Hon.A.R.C.S.

Readers : Zoology.—†H. R. Hewer, M.Sc., A.R.C.S., D.I.C. ; *Entomology.*—†O. W. Richards, M.A., D.Sc. ; *Applied Entomology* (*Insecticides*).—†A. B. P. Page, Ph.D., A.R.C.S. ; *Applied Entomology* (*Tropical*).—†W. F. Jepson, O.B.E., Ph.D., A.R.C.S.

Lecturers.—O. F. Lubatti, D.Chem., M.Sc. ; D. R. P. Murray, M.A., Ph.D. ; H. Gorvett, Ph.D. ; Miss N. Waloff, Ph.D. ; Miss L. E. Wagge, Ph.D., B.Sc. ; R. G. Davies, B.Sc., A.R.C.S. ; A. E. H. Higgins, A.R.C.S., D.I.C. ; Mrs. D. M. Kermack, B.Sc., D.I.C. ; K. Boratynski, Ph.D.

Assistant Lecturers.—Miss B. Jacobs, B.Sc. (part time) ; H. E. Goto, B.Sc. ; P. T. Haskell, B.Sc., A.R.C.S.

Demonstrator.—Miss E. U. Canning, B.Sc., A.R.C.S.

Field Station

Director.—†Professor J. W. Munro, C.B.E., M.A., D.Sc., Hon.A.R.C.S.

Clerk of Works.—J. S. Porter.

Administrative Assistant.—P. T. Haskell, B.Sc., A.R.C.S.

Special Lecturer (*Arts*).

Reginald Jacques, D.Mus., M.A., F.R.C.M.

† Appointed Teacher of the University of London.
* Recognised Teacher of the University of London.

ADMINISTRATIVE STAFF

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Sir Roderic Hill, K.C.B., M.C., A.F.C.

Dean of the City and Guilds College.
Professor Willis Jackson, D.Sc., D.Phil., M.I.E.E., F.Inst.P.

Dean of the Royal College of Science.
Professor H. Levy, M.A., D.Sc., F.R.S.E.

Dean of the Royal School of Mines.
Professor D. Williams, D.Sc., Ph.D., B.Eng., D.I.C., M.I.M.M., F.G.S.

Clerk to the Governors (Secretary of the Imperial College) and Secretary to the Delegacy of the City and Guilds College.
G. C. Lowry, T.D., M.A.

Registrar and Assistant Secretary.
E. F. Cutcliffe, M.B.E., B.A.

Financial Secretary.
J. M. Corin, B.A.

Administrative Secretary.
C. K. McDowall, B.A.

Staff Clerks : Miss C. Sherwood, E. R. Taylor and Miss M. J. Burns.

Finance Clerk.
F. W. G. Annas.

Cashier.
P. B. Poulain.

Deputy Registrar, C. & G. : J. Walker.

Deputy Registrar, R.C.S. & R.S.M. : B. W. Kerrigan, B.A.

Staff Clerks : Miss C. G. Robertson, Miss L. D. Noble and Miss G. Pillar.

Supplies Clerk.
R. J. K. Harley.

Stores Clerk : A. G. Moore.

Maintenance Officer.
A. C. Singleton, A.R.I.C.S., A.M.I.Mun.E.

Assistant Maintenance Officer.
T. H. Lewis.

Clerk of Works : F. E. Whebby.

Superintendent of Vacation Studies.
J. Newby.

Assistant Superintendent.
E. Fairhurst, M.A.

Librarian (C. & G.).
F. W. James, B.Sc., A.R.C.S.

Assistant Librarian.
Miss M. H. Prat.

Offices : Prince Consort Road, London, S.W.7, except the Office of the Deputy Registrar, City and Guilds College, which is in Exhibition Road, London, S.W.7.

Telephone (all Departments) : KENsington 4861.

PAST RECTORS, EMERITUS PROFESSORS AND FELLOWS

PAST RECTORS OF THE IMPERIAL COLLEGE

1908–10. Henry T. Bovey, LL.D., D.C.L., F.R.S.
1910–22. Sir Alfred Keogh, G.C.B., G.C.V.O., C.H., LL.D.
1922–29. Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., LL.D., F.R.S.
1929–42. Sir Henry T. Tizard, G.C.B., M.A., F.R.S.
1942–48. Sir Richard Southwell, M.A., LL.D., F.R.S.

EMERITUS PROFESSORS

(*Names of deceased Professors are omitted.*)

Aeronautics.

Bairstow, Sir Leonard, C.B.E., D.Sc., D.Eng., A.R.C.S., F.R.S.

Applied Physical Chemistry.

Finch, G. I., M.B.E., D.Sc., Dipl. Tech. Chem. (Zurich), F.Inst.P., Hon. A.C.G.I., F.R.S.

Biochemistry.

Chibnall, A. C., M.A., Sc.D., Ph.D., F.R.S.

Botany.

Blackman, V. H., M.A., Sc.D., F.R.S.

Chemical Technology.

Egerton, Sir Alfred, C.G., M.A., D.Sc., F.R.I.C. F.Inst.P., M.I.Chem.E., Hon. A.C.G.I., F.R.S.

Organic Chemistry.

Heilbron, Sir Ian, D.S.O., D.Sc., Ph.D., LL.D., F.R.I.C., F.R.S.

Geology.

Boswell, P. G. H., O.B.E., D.Sc., A.R.C.S., D.I.C., M.I.M.M., F.R.S.

Highway Engineering.

Clements, R. G. H., M.C., M.I.C.E.

Mechanical Engineering.

Witchell, E. F. D., B.Sc., M.I.Mech.E., F.C.G.I.

Meteorology.

Brunt, Sir David, M.A., Sc.D., D.Sc., Hon. A.R.C.S., Sec.R.S.
Walker, Sir Gilbert Thomas, C.S.I., Sc.D., M.A., F.R.A.S., F.R.S.

Mining.

Ritson, J. A. S., D.S.O., O.B.E., M.C., B.Sc., M.I.Min.E., M.I.M.M., Hon. A.R.S.M.

Mining Geology.

Jones, W. R., C.B.E., D.Sc., D.I.C., M.I.M.M.

Physics.

Rankine, A. O., O.B.E., D.Sc., F.R.S.
Thomson, Sir George P., M.A., Hon. A.R.C.S., F.R.S.

HONORARY FELLOWS OF THE IMPERIAL COLLEGE

(Names of deceased Fellows are omitted).

1934.

CHATTERTON, Sir ALFRED, C.I.E., B.Sc., A.C.G.I., M.I.E.E., F.C.G.I. (C. & G. 1885–87).

ECCLES, WILLIAM H., D.Sc., A.R.C.S., F.R.S. (R.C.S. 1894-97).

1937.

DRYSDALE, C. V., C.B., O.B.E., D.Sc., A.C.G.I., F.R.S.E., F.C.G.I. (C. & G. 1890–93).

SMITH, Sir FRANK E., G.B.E., G.C.B., D.Sc., LL.D., A.R.C.S., F.R.S. (R.C.S. 1896–99).

1939.

FABER, OSCAR, C.B.E., D.Sc., LL.D., A.C.G.I., M.I.C.E., F.C.G.I. (C. & G. 1903–06).

1941.

SMITH, SYDNEY WILLIAM, C.B.E., D.Sc., A.R.S.M., M.Inst.M.M. F.R.I.C. (R.S.M. 1896–99).

1942.

TIZARD, Sir HENRY T., G.C.B., M.A., F.R.S.

1943.

LAWN, J. G., C.B.E., D.Sc.(Eng.) (R.S.M. 1886-91).

LEA, F. C., O.B.E., D.Sc., M.I.C.E., M.I.Mech.E. (R.C.S. 1893–96).

TWYMAN, F., F.R.A.S., F.Inst.P., F.C.G.I., F.R.S. (C. & G. 1894–97).

1944.

FALMOUTH, The Rt. Hon. The Viscount.

1945.

GARLAND, C. S., B.Sc., A.R.C.S., F.R.I.C., P.P.I.Chem.E. (R.C.S. 1905–08).

MCCANCE, Sir ANDREW, D.Sc., F.R.S. (R.S.M. 1906–09).

VAN RYNEVELD, Lt.-Gen. Sir PIERRE, K.B.E., C.B., D.S.O., D.F.C., M.C., B.Sc., F.C.G.I. (C. & G. 1911–14).

WIMPERIS, H. E., C.B., C.B.E., M.A., D.Eng., F.R.Ae.S., M.I.E.E. (R.C.S. 1896–98).

1946.

BLACKMAN, Professor V. H., M.A., Sc.D., F.R.S. (R.C.S. 1911–37).

GOW, ALEXANDER, M.A., B.Sc. (1908–34).

PRIDEAUX, WALTER T., LL.D.

SHAW, Sir EVELYN CAMPBELL, K.C.V.O., LL.D.

THORNYCROFT, Sir JOHN EDWARD, K.B.E., F.C.G.I., M.I.C.E., M.I.Mech.E., M.I.N.A., M.I.A.E., M.Inst.Met. (C. & G. 1890–92).

WALKER, Professor Sir GILBERT T., C.S.I., Sc.D., M.A., F.R.A.S., F.R.S. (R.C.S. 1924–34).

WHITELEY, Dr. MARTHA A., O.B.E., D.Sc., F.R.I.C. (R.C.S. 1898–1934).

1947.

DAWSON, WARREN R., F.R.S.E., F.R.S.L., F.S.A., F.R.A.I.

HALL, Instructor Rear-Admiral Sir ARTHUR E., K.B.E., C.B. (R.C.S. 1903–07).

1948.

JOHNSON, JOHN, C.B.E., M.A., D.Litt.

WITCHELL, Professor EMERITUS E. F. D., F.C.G.I., B.Sc., M.I.Mech.E. (C. & G. 1898–1946).

1949.

COMPTON, KARL TAYLOR, D.Sc., D.Eng., Ph.D., D.L.A.

ELLINGHAM, H. J. T., A.R.C.S., Ph.D., M.I.Chem.E., F.I.M., F.R.I.C. (R.C.S. 1914–16).

RICKARD, T.A., A.R.S.M., D.Sc., Hon.M.I.M.M. (R.S.M. 1882–85).

SELKIRK, WILLIAM.

1950.

DYSON, Sir GEORGE, M.A., Mus.D.(Oxon.), Hon.LL.D.(Aberdeen), F.R.C.M., Hon.R.A.M.

HUNSAKER, Professor J. C., M.S., Sc.D.

SOUTHWELL, Sir RICHARD, M.A., LL.D., M.I.Mech.E., F.R.Ae.S., F.R.S.

STEWARD, Sir HENRY A.

1951.

ANNAN, ROBERT, B.E.(Columbia).

FAIR, Professor GORDON MASKEW, S.M.

HEILBRON, Sir IAN M., D.S.O., D.Sc., Ph.D., LL.D., F.R.S.

McDERMOTT, EDWARD D., A.R.S.M.

HANDLEY PAGE, Sir FREDERICK, C.B.E., Hon.F.R.Ae.S., F.C.G.I.

ROBSON, STANLEY, B.Sc., M.Sc., D.I.C., M.I.Chem.E., M.I.M.M.

1952.

BAIRSTOW, Professor Sir LEONARD, C.B.E., D.Sc., D.Eng., A.R.C.S., F.R.S.

CLEMENTS, RAYMOND GEORGE HUBERT, M.C., M.I.C.E.

HEWITT, Professor JOHN THEODORE, O.B.E., M.A., Ph.D., D.Sc., A.R.C.S., F.R.S.

HUTTON, Professor ROBERT SALMON, M.A., D.Sc.

FELLOWS OF THE CITY AND GUILDS OF LONDON INSTITUTE

(*Names of deceased Fellows are omitted*).

1904.

BOOTH, HUBERT CECIL, M.I.C.E.

1911.

DEERR, NOEL FIELDING.

1913.

CHATTERTON, Sir ALFRED, C.I.E., B.Sc., A.M.I.C.E., M.I.Mech.E.

1925.

BRAMWELL, FRANCIS HERBERT, B.Sc., A.M.I.C.E., F.R.Ae.S., A.M.I.Mech.E.

1928.

BUCKLEY, ARTHUR BURTON, O.B.E., M.I.C.E.

DRYSDALE, CHARLES VICKERY, C.B., O.B.E., D.Sc., M.I.E.E., F.Inst.P., F.R.S.E.

SOLOMON, MAURICE, M.I.E.E.

TRIPP, GEORGE WALTER, O.B.E., M.I.C.E., M.I.Mech.E.

1929.

FABER, OSCAR, C.B.E., D.Sc.(Eng.), M.I.C.E., A.M.I.E.E., M.Inst.Struct.E.

LE MAISTRE, CHARLES DELACOUR, C.B.E., A.M.I.C.E., M.I.E.E.

O'GORMAN, MERVYN JOSEPH PIUS, C.B., D.Sc., M.I.C.E., M.I.E.E., M.I.Mech.E., M.I.A.E., F.R.Ae.S.

WILSON, JOHN SIEGMOND, M.I.C.E.

1930.

RICH, EDMUND MILTON, C.B.E., B.Sc., F.C.S.

1931.

MARCHANT, EDGAR WALFORD, D.Sc., M.I.E.E.

TWYMAN, FRANK, F.Inst.P., F.R.S.

1933.

DONALDSON, JOHN MUIR, M.C., M.I.C.E., M.I.E.E.

HICKS, GEORGE AUGUSTUS, V.D., M.I.C.E.

THORNYCROFT, Sir JOHN EDWARD, K.B.E., M.I.C.E., M.I.Mech.E., M.I.N.A., M.I.A.E., M.Inst.Met.

1934.

ARMSTRONG, HAROLD LAVERS.

WITCHELL, EDWARD FRANK DALBY, B.Sc., M.I.Mech.E.

1935.

ELLIS, ALFRED GEORGE, M.I.E.E.

1936.

CONSTABLE, ARTHUR DOUGLAS, O.B.E., M.I.E.E.

HAGUE, BERNARD, D.Sc.(Eng.), Ph.D., D.I.C., M.I.E.E., F.P.S.L.

HARTLEY, ARTHUR CLIFFORD, C.B.E., B.Sc.(Eng.), M.I.C.E., M.I.Mech.E.

HOLLINGWORTH, JOHN, M.A., D.Sc.(Eng.), M.I.E.E.

WALKER, EDWARD GEORGE, B.Sc.(Eng.), M.I.C.E., M.I.Mech.E., M.Am.Soc.C.E., F.R.Ae.S., A.I.N.A.

1937.

JONES, CYRIL WALTER, C.I.E., M.I.C.E.

SELIGMAN, RICHARD JOSEPH, Ph.D., F.C.S., M.I.S.I., Fellow of Institute of Metals.

1938.

NEWHOUSE, FREDERICK, M.I.C.E.

1939.

FAIREY, Sir CHARLES RICHARD, M.B.E., F.R.Ae.S.
FAWSSETT, EVELYN, M.I.E.E.
PAGE, Sir FREDERICK HANDLEY, C.B.E., F.R.Ae.S.

1940.

ARMSTRONG, HARRY CLIFFORD, O.B.E., M.I.C.E., F.Inst.F.
DESCH, CYRIL HENRY, D.Sc., Ph.D., F.R.I.C., F.R.S.
FLEMING, Sir ARTHUR PERCY MORRIS, C.B.E., D.Eng., M.Sc., M.I.E.E., M.I.Mech.E.
SMITH, STANLEY LIVINGSTONE, C.B.E., D.Sc., M.I.Mech.E.

1941.

CARR, FRANCIS HOWARD, C.B.E., D.Sc., F.R.I.C.
EYRE, JOHN VARGAS, M.A., Ph.D., F.R.I.C.
ROSEN, JESSEL, B.Sc.(Eng.), M.I.C.E., M.I.E.E.
VAN RYNEVELD, Lt.-Gen. Sir PIERRE, K.B.E., C.B., D.S.O., M.C., D.F.C., B.A., B.Sc.(Eng.).

1944.

BAKER, JULIAN LEVETT, F.R.I.C., F.C.S.
BATE, ERNEST, M.C., B.Sc.(Eng.).
NELSON, Sir GEORGE HORATIO, M.I.E.E., M.I.Mech.E.
WHALLEY, FREDERICK SEYMOUR, M.C., M.I.Mech.E., M.I.Loco.E.

1946.

BISHOP, HAROLD, C.B.E., B.Sc.(Eng.), M.I.E.E., M.I.Mech.E.
PENDRED, LOUGHNAN ST. LAWRENCE, C.B.E., M.I.Mech.E., M.I. & S.Inst.
SAMS, CHARLES EGBERT REYNOLDS, M.I.Mech.E., F.Inst.F., M.Inst.Pet.
SPROULL, ALEXANDER WALLACE, C.B., C.B.E., B.Sc.(Eng.), M.I.Mech.E., M.I.E.E., M.I.E.I.
WHITE, Sir BRUCE GORDON, K.B.E., M.I.C.E., M.I.Mech.E., M.I.E.E.

1947.

HOLBEIN, Capt. ARTHUR MONTAGUE, C.B.E., B.Sc.(Eng.), M.I.C.E., D.I.C.

1949.

GRINSTED, HAROLD, C.B.E., B.Sc.(Eng.), F.R.Ae.S.
GRINSTED, WILLIAM HERBERT, M.B.E., M.I.E.E.
LACEY, GERALD, C.I.E., B.Sc.(Eng.), M.I.C.E., M.I.W.E., F.R.S.A.
MITCHELL, Sir KENNETH GRANT, K.C.I.E., M.I.C.E., M.Inst.T., M.I.E.(Ind.).

1950.

ROCHE LYNCH, GERALD, O.B.E., M.R.C.S., F.R.I.C.
SAUNDERS, Sir HAROLD LEONARD, A.C.G.I., B.Sc.(Eng.).
SCOTT-HALL, STEWART, C.B., A.C.G.I., D.I.C., M.Sc.(Eng.), F.R.Ae.S.
SMITH-ROSE, REGINALD LESLIE, O.B.E., D.Sc., A.R.C.S., D.I.C., M.I.E.E.,
TUDSBERY, MARMADUKE TUDSBERY, C.B.E., M.I.C.E.

1951.

BLAIR, ATHOLL, C.B.E., M.I.Mech.E.
SHOOSMITH, HARRY, M.I.C.E., M.I.Mech.E., Wh.Sch.

GENERAL INFORMATION

CONSTITUENT COLLEGES AND DEPARTMENTS

ROYAL COLLEGE OF SCIENCE

The following departments and sub-departments of the Imperial College are included in the Royal College of Science :—

BOTANY (with sub-departments of Plant Physiology, Plant Pathology, Bacteriology, and Biochemistry).

CHEMISTRY (Inorganic and Physical, and Organic, with sub-departments of Agricultural Chemistry, and the Chemistry of Food and Drugs).

GEOLOGY (*except* the sub-departments of Mining Geology and Oil Technology).

MATHEMATICS.

*METEOROLOGY.

PHYSICS (with sub-departments of Astrophysics, Technical Optics and Applied Geophysics).

ZOOLOGY AND APPLIED ENTOMOLOGY.

The undergraduate courses lead to the Associateship of the Royal College of Science (A.R.C.S.) and the Degree of B.Sc. (Special) of the University of London in one of the main subjects mentioned above, except Meteorology. All the courses extend over three years, but a limited number of candidates for the courses in Physics, Botany, Zoology or Geology may be admitted to an additional year in order to take the Preliminary examination at the College.

Facilities are also provided for advanced study or research, leading normally to the Diploma of Membership of the Imperial College (D.I.C.), and/or to a higher Degree of the University of London.

ROYAL SCHOOL OF MINES

The following departments and sub-departments of the Imperial College are included in the Royal School of Mines :—

MINING.

METALLURGY.

MINING GEOLOGY, OIL TECHNOLOGY } sub-departments of Geology.

The undergraduate courses lead to the Associateship of the Royal School of Mines in one of these subjects, and to the Degree of B.Sc. in the Faculty of Engineering when the subject is either Mining or Metallurgy, or B.Sc. (Special) in the Faculty of Science when the subject is Mining Geology or Oil Technology.

All the courses extend over three years, but a limited number of candidates may be admitted to an additional year in order to take the Preliminary examination at the College.

Facilities are also provided for advanced study or research, leading normally to the Diploma of Membership of the Imperial College (D.I.C.), and/or to a higher Degree of the University of London.

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* Department for postgraduate work only.

CITY AND GUILDS COLLEGE

The following departments of the Imperial College are included in the City and Guilds College :—

AERONAUTICS (including Aerodynamics, Aero-Structures and Aircraft Propulsion).

CHEMICAL ENGINEERING AND APPLIED CHEMISTRY.

CIVIL ENGINEERING.

ELECTRICAL ENGINEERING.

MECHANICAL ENGINEERING.

The undergraduate courses extend over three years for all branches of Engineering, viz., Aeronautical, Chemical, Civil, Electrical, Mechanical, and lead to the Associateship of the City and Guilds of London Institute (A.C.G.I.) and the B.Sc.(Eng.) Degree. (Students of Aeronautical Engineering will spend the first two years in Mechanical Engineering.) Students who have qualified in Physics or Mathematics may also enter the Department of Aeronautics ; students proceeding to a Degree in Physics may spend their third undergraduate year in the Aeronautics Department.

The three years are known as the first, second and third years respectively. The work of the first year is the same for students in all the Departments above except Chemical Engineering. That of the second and third years is arranged to allow students to spend most of their time in the particular department chosen.

Arrangements have been made with certain firms whereby undergraduate students of Aeronautical, Electrical, and Mechanical Engineering may spend a year in practical work at the end of their Part II Course and before taking Part III.

Students who wish to take advantage of this scheme should consult the Head of their Department, and also the Deputy Registrar of the City and Guilds College.

Advanced study and research form an important part of the College work ; courses lead to the Diploma of Membership of the Imperial College (D.I.C.), and/or to a higher Degree of the University of London.

WOMEN STUDENTS

Women are accepted on an equal basis with men for the College courses ; opportunities occur mainly on the science side. The number of women students is around fifty, and the Women's Association takes an active part in the life of the College.

ASSOCIATED INSTITUTIONS

The Charter of the College provides that, subject to agreement with the authorities of any college or other institution, the Governing Body may by resolution recognise that college or institution or any department thereof as being in association with the Imperial College for all or any of the purposes of the Charter, but no such resolution is to be operative until allowed by the Queen in Council. The Department of Metallurgy of the University of Sheffield has been so recognised for the Advanced Metallurgy of Iron and Steel ; students

wishing to follow this course in their third year should apply to the Registrar for particulars.

The College has formed an alliance with the Massachusetts Institute of Technology for the interchange of postgraduate students and members of staff. It has also concluded an alliance with the Indian Institute of Science, Bangalore.

An arrangement has been made for the annual exchange of a postgraduate student with the Swiss Federal Institute of Technology, Zurich.

JOINT POSTGRADUATE STUDIES IN TECHNOLOGY, ECONOMICS AND ADMINISTRATION

The growth of the natural and social sciences and their impact on the development, organisation and management of business and public affairs are creating both opportunities and problems which cut across conventional faculty boundaries. The Imperial College of Science and Technology and the London School of Economics and Political Science are therefore making joint arrangements to enable postgraduate students to take advantage of the combined facilities of the two schools.

The two schools will collaborate in encouraging research which will throw light on the direction, strength and interplay of scientific, technological, social and market forces. For example, opportunities will be provided for studies of the growth of science-based industries, of the economic prospects of technological developments, of the factors affecting industrial productivity, and of the economics and organisation of research itself. For some of these studies a desirable training is a thorough grounding in an appropriate field of science and technology coupled with an appreciation of the relevant social sciences. Others may require a thorough grounding in the appropriate branches of the social sciences coupled with an appreciation of developments in natural science and technology.

Postgraduate research students accepted by either the Imperial College or the London School of Economics for this type of work will receive guidance and help from *both* schools. Where it is advisable the student will be placed under two supervisors, one at each school.

Arrangements have also been made to assist postgraduate students whose purpose is to broaden and deepen their education and training rather than to engage in research. Opportunities are to be provided for scientists and technologists to make themselves familiar with labour, finance, marketing and other aspects of industry. Similar opportunities are to be provided for economists, accountants, lawyers, etc., to make themselves acquainted with the role of science and its industrial applications.

Students of Imperial College who have been accepted for a postgraduate course in science or technology and who wish to acquire an introductory knowledge of such subjects as economics, law, history and administration, will be afforded facilities to do so at the London School of Economics. Courses of study will be arranged to meet the individual needs of each student.

Imperial College will provide for students of the London School of Economics special courses designed to illustrate typical developments

in science and their application to industry, and to give the student some acquaintance with industrial materials and products, manufacturing processes and equipment. Although these courses are open to other postgraduate students of the School, they are especially intended for those who are taking the full-time One-Year Course of Training in Business Administration and have graduated in subjects outside the science and engineering faculties.

Arrangements relating to higher degrees have been made by the University of London to facilitate postgraduate studies which overlap the faculties of Science, Engineering and Economics. Subject to the University Regulations candidates are permitted to proceed to a higher degree based upon a field of study falling mainly or partly in a faculty different from that in which the first degree was obtained.

In addition to other scholarships and awards which may be open to postgraduate students of the two schools, attention is specially drawn to the Postgraduate Maintenace Grants offered by the Department of Scientific and Industrial Research. In order to stimulate research of the kind described above and the training of men and women competent to undertake it, these grants are now available for honours graduates in pure or applied science to be trained in the investigation of problems concerning industrial productivity and organisation. Applications should be made to the Secretary, Department of Scientific and Industrial Research, Charles House, 5-11, Regent Street, London, S.W.1.

Further information relating to the above arrangements can be obtained from the Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7, or the Registrar, The London School of Economics and Political Science, Houghton Street, London, W.C.2.

RELATIONS BETWEEN THE IMPERIAL COLLEGE AND INDUSTRY

The relations of the College with industry have always been close. Seven members of the Governing Body of the College are appointed on the nomination of professional societies ; and special committees, with strong industrial representation, advise the Governing Body from time to time on various aspects of education in advanced technology. Apart from these formal connexions with industry, there are valuable informal connexions, Many members of the staff of the College have had long industrial experience, and the Governing Body encourages any arrangements which enable the staff and students to keep in touch with technical developments in the industrial world.

It is common practice for students to spend part of their long vacations in acquiring practical experience of their branch of science or technology and this is facilitated by the action of many well-known firms who make special arrangements for the admission of students into their works (see also I.C. Union Vacation Work Scheme, p.43). In much of its research work the College is closely associated with Government Departments and industrial firms.

The placing of students in industrial and other posts is facilitated by the Imperial College Appointments Board, assisted by Heads of Departments.

IMPERIAL COLLEGE APPOINTMENTS BOARD

An Appointments Board for the Imperial College was established in 1912 for the purpose of assisting Associates of the Royal College of Science, the Royal School of Mines, the City and Guilds of London Institute, and the holders of the Diploma of Membership of the Imperial College in obtaining employment on the completion of their respective College courses.

The Board consists of the Rector of the Imperial College, Chairman, with six Professors of the College, and two representatives of each of the Old Students' Associations of the Royal College of Science, the Royal School of Mines, and the City and Guilds College, and has the valued co-operation of all the Professors of the College.

Students are advised to enter their names on the register provisionally at the beginning of their final term's work, and definitely as soon as that term is completed.

There are no fees.

All communications regarding appointments by students of the City and Guilds College should be addressed to the Deputy Registrar of that College, and by all other students to the Registrar of the Imperial College. Matters of general business should be addressed to the Registrar, Imperial College, S.W.7.

CAREERS

Pamphlets regarding the careers to which the College courses lead have been produced and copies relating to individual Departments are available on application to the Registrar.

LIBERAL ASPECT OF EDUCATION

In view of the specialised nature of the instruction and research at Imperial College, the College attaches due importance to the encouragement of broad interests : to the development of those human qualities that contribute to effective judgment, creative thinking, and a liberal view of life.

These aims are already inherent in work done at the College, as, for example, in certain lectures already given in the normal course of teaching ; and in vacation work, which helps to bring theoretical knowledge into relationship with the world outside the laboratory and the lecture room. Certain student clubs provide additional opportunities for the enjoyment and practice of cultural and social activities.

The need has been felt among members of the College, however, for wider opportunities of intellectual exchange, so that the more general interests that emerge from Departments and student societies may be furthered at College level. Time is allowed, therefore, for special lectures or courses on " Background " subjects which are related to specialist studies and at the same time give them wider perspective. Inter-Departmental lectures are a further example ; these are given by each Department in turn, so that members of other Departments may know something of the broad principles and human purposes underlying each specialised discipline.

In addition, residential week-end discussion parties are held at Silwood Park, Berks, the Imperial College Field Station, at which the aim is to relate the scientific and technological point of view with that of the arts or humanities.

The policy of the College is to promote these and similar activities. In general they are informal in character, following the changing or developing needs of the College. They are regarded both as of intrinsic educational value, and as a form of relaxation from the prescribed academic courses.

LIBRARY FACILITIES

Subject to the regulations determined by the respective departments, students attending the Imperial College have the privilege of free access to the Departmental Libraries, a privilege which is also accorded to those who have obtained the Associateship of the Royal College of Science, the Royal School of Mines, the City and Guilds of London Institute or the Diploma of the Imperial College.

There is also an extensive library at the City and Guilds College.

The library of the Science Museum (usually known as the Science Library) is similarly accessible to Imperial College students and, in addition, Imperial College students registered for post-graduate work may, subject to certain conditions, receive books from this Library on loan for purposes of study and research.

The University of London Library of about 500,000 books is open from 10 a.m. to 8 p.m. (6 p.m. on Saturdays). It is equipped with reference rooms for study, and many books may also be borrowed for home reading. Application for permission to use the Library should be made to the Goldsmiths' Librarian, University of London Library, Senate House, W.C.1.

ACADEMIC COSTUME

The Academic Costume authorised by the Governing Body to be worn by Diplomates of the Imperial College and of its three integral parts is as follows :—

Gown.

(*For Diplomate Students of the Imperial College* (*i.e., D.I.C.*) *and for Associates of the integral parts of the Imperial College* (*i.e., A.R.C.S., A.R.S.M., or A.C.G.I.*).)

As the University of London B.A. gown, of black silk or black stuff, but with the forearm seam open and without button, cord or pleats.

Hoods.

(*For Diplomate Students of the Imperial College* (*i.e., D.I.C.*).)

As the Oxford University M.A. hood in size and shape, of black silk or black stuff, partly lined with white watered silk to a depth of six inches, with an edging, one inch in width, of royal purple velvet, half an inch from the outer edge, and with a neckband of black silk one and a quarter inches in width, lined with white watered silk, and edged with white watered silk one quarter inch in width.

(*For Associates of the Royal College of Science* (*i.e., A.R.C.S.*).)

As for Diplomate Students of the Imperial College, except that the black portion of the neckband of the hood is replaced by white silk.

(*For Associates of the Royal School of Mines* (*i.e., A.R.S.M.*).)

As for Diplomate Students of the Imperial College, except that the black portion of the neckband is replaced by old gold coloured silk.

(*For Associates of the City and Guilds of London Institute* (*i.e., A.C.G.I.*).)

As for Diplomate Students of the Imperial College, except that the black portion of the neckband is replaced by red (as in the arms of the City of London) coloured silk.

Robes, etc., may be obtained from Messrs. Ede and Ravenscroft, 93-94, Chancery Lane, W.C.2.

ADMISSION TO COURSES ; FEES AND EXPENSES

Information regarding conditions of admission to courses and fees is given in the Prospectus which may be obtained on application to the Registrar.

OVERSEAS STUDENTS—MEDICAL EXAMINATION

Overseas students are only accepted subject to a satisfactory medical examination in this country.

DIPLOMAS AND DEGREES

Diplomas

Students who have regularly attended specified courses and have satisfied the examiners, are awarded the Diploma of Associateship of the Royal College of Science (A.R.C.S.), or of the Royal School of Mines (A.R.S.M.) or of the City and Guilds of London Institute (A.C.G.I.).

In the case of the A.R.C.S. and the A.R.S.M. the award is classified as 1st Class Honours, 2nd Class Honours, or Pass. In the case of the A.C.G.I. there is no classification. A Diploma will not be granted to a student until he has completed at least two years' approved work in the College.

The records of candidates for an Associateship who fail in examinations are considered annually in July. Decisions are then taken as to whether re-examinations only are to be allowed, whether courses of study and examinations are to be repeated or whether the student concerned is to withdraw from the College.

The normal unit for examination and re-examination in Associateship final courses is one year ; for other courses candidates may be re-examined in a single subject. The College fee for re-examination in each of the final courses is £2 2*s*. 0*d*., and in a single subject £1.

Certificates may be granted to students who are not eligible for a Diploma.

Regulations for the Diploma of the Imperial College of Science and Technology (D.I.C.)

(1) The Diploma of the Imperial College of Science and Technology (D.I.C.) will be awarded to students in Pure or Applied Science, who, having followed an approved postgraduate course of research, and/or advanced study, extending over not less than one year, are recommended for the award on the ground of the high quality of their work.

(2) The Diploma shall in no circumstances be awarded for a course of study which is taken by students of the Imperial College as part of the qualification for an initial Degree.

(3) The course of study or research must be pursued under the direction of a Professor of the Imperial College of Science and Technology, within the Imperial College, except :—

(i) in cases where the Imperial College, in accordance with Article V of the Charter, recognises for this purpose in Associated Universities, University Colleges, or Institutions of equal rank, courses of study for which the Imperial College does not make provision in any of its constituent Colleges ;

(ii) in cases specially approved for the purpose by the College authorities.

(4) Each candidate for the Diploma must be an Associate of one of the constituent Colleges or must satisfy the College authorities that he has attained to the standard represented thereby, except in cases approved by the Board of Studies on the recommendation of the Head of a Department. (Particulars of Degrees awarded by a University or of other distinctions may be submitted as evidence of the necessary standard of attainment.)

(5) Holders of a College Associateship are not required to register for this Diploma. Other candidates must register within one term of entering upon the course. If application is made after this period a fee of 10*s*. 6*d*. will be charged.

(6) The Diploma may be awarded either on a thesis or by examination, which may be by dissertation ; the requirement in each case will be decided by the Head of the Department.

A candidate submitting a thesis must deliver to the Registrar two copies of the thesis describing his Research. One of these must be bound in the approved style.* The copies of a thesis accepted for the D.I.C. shall become the property of the Governors of the College who will not, however, print the thesis, or any part of it, without the consent of the author and his Professor. The thesis shall be available for reference by persons authorised by the Rector after consultation with the Professor concerned.

A candidate examined by dissertation must deliver one copy of his dissertation (this may consist of design drawings accompanied by an explanatory statement and calculations).

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* Size of paper: quarto, approximately 10 inches by 8 inches, except for drawings and maps. A margin of 1½ inches to be on the left-hand side. Bound in a standardised form as follows: quarter art vellum or cloth overcast; edges uncut; lettered boldly up back in gold (¼ inch to ½ inch letters): DATE, NAME, DEPARTMENT; short title written or printed neatly and legibly on the front cover.

Degrees

The Imperial College of Science and Technology is a School of the University of London, and students of the College who are registered for an Associateship and who fulfil the University requirements are eligible to proceed to the B.Sc. (Special) Degree or to the B.Sc. (Engineering) Degree of the University of London. The B.Sc. (General) Degree cannot be taken on the College courses.

Under the agreement between the University and the College, and until further notice, the same courses and examinations serve for the College Associateship and for the B.Sc. Degree of the University, provided that the student has complied with the University and the College regulations.

Candidates who desire to proceed to a Degree in the University of London on an Associateship course must have qualified for University Entrance; candidates should submit their examination results to the Secretary, University Entrance and School Examinations Council, Senate House, W.C.1, to make sure they are qualified.

Students must apply at the Registry at the appropriate times for entry forms. For the information of candidates notices are posted in College Halls at the beginning of the Session drawing attention to the latest dates for entries for University examinations during the year.

STUDENT AFFAIRS

STUDENTS' UNIONS, SOCIETIES AND CLUBS

Every full-time student of any of the three constituent Colleges of the Imperial College whose fee has been paid is automatically a member of two Unions :—

(i) The Imperial College Union (I.C.U.).

(ii) The students' individual College Union, i.e., one of the following :—

The Royal College of Science Union (R.C.S.U.),
The Royal School of Mines Union (R.S.M.U.),
The City and Guilds College Union (C. and G.C.U.).

THE IMPERIAL COLLEGE UNION (I.C.U.)

The Imperial College Union is an institution serving the athletic and social needs of students of the Imperial College while following their courses of study at South Kensington.

Membership is open to present and former students of the Imperial College, including the Royal College of Science, the Royal School of Mines, and the City and Guilds College, as well as to the members of the Staff and the Governors of the College. The composite fee paid by a student taking a full session's course in any year entitles him to membership of the Union for that year without further payment. The terms of membership for other students may be obtained on application to the Honorary Secretary of the Imperial College Union, Prince Consort Road, S.W.7.

The affairs of the Imperial College Union, of which all students of the three constituent Colleges are members, are under the control of the I.C.U. Council. The President of the I.C.U., who is chairman of this Council, is elected from nominations of the general student body at a joint meeting of new and retiring Councils at the end of the session. The Honorary Secretary of the I.C.U. is elected at the same meeting. The I.C.U. Council also includes the three Presidents of the individual College Unions, who are Vice-Presidents of the I.C.U., one other representative elected by and from each of the individual College Unions, six student representatives elected by and from a general meeting of the Imperial College Union, a member of the academic staff of the Imperial College to act as Honorary Treasurer, the President of the I.C. Women's Association, a representative of each of the Old Students' organisations of the three Colleges, the Chairman of the I.C. Athletic Clubs Committee, the Chairman of the I.C. Social Clubs Committee, the Chairman of the I.C.U. Entertainments Committee, and the Chairman of the Silwood Park Committee. The I.C.U. Council determines the general policy of the I.C.U. and its relations with outside bodies and is itself responsible to the general student body.

All women members of Imperial College Union are also members of the I.C. Women's Association which exists for the promotion of social contact between past and present women students and to safeguard and advance the interests of women students at the College.

Imperial College Union Building.—This building is the administrative home of the Imperial College Union itself, and it is also available for meetings of the principal Clubs and Societies of the Imperial College, the Royal College of Science, the Royal School of Mines, and the City and Guilds College. Rooms allocated entirely for the use of members of the I.C.U. and the individual College Unions include the Lounge, the Gymnasium, the Committee Rooms, and the Bar —in the main Imperial College Union Building (commonly known as " the Union ")—and the New Lounge in the Beit Building on the opposite side of the quadrangle ; the library and the reading rooms are in the Unwin Building ; rooms in the east wing of the main Union building are set aside for the use of women members. The *Executive Committee*, consisting of the President and Honorary Secretary of the I.C.U. and the three Vice-Presidents, deals with matters concerning the amenities of these rooms or refers such matters to the Council.

The kitchen and dining rooms in the main Union Building are under the control of the *Imperial College Refectory Club*, which is formed for the purpose of supplying meals and refreshments to members of the academic staff of the Imperial College and members of the I.C.U. The Refectory Committee consists of four members of the academic staff, the President of the I.C.U., the three Presidents of the individual College Unions, the President of I.C.W.A. and representatives of the Residents Committee. An à la carte luncheon is served on week-days, also a buffet lunch in the New Lounge. Members of the Imperial College Hostel breakfast and dine in the main Dining Room of the Refectory Club.

The Imperial College Bookstall is in the Beit Building, where all text-books, instruments, stationery, sports clothes, etc., required by students, can be obtained. The books and instruments stocked are such as have been approved by the Professors of the College. The Bookstall is managed by a Committee composed of two senior members of the staff appointed by the Rector, and five student members appointed by the respective College Unions. *The profits from the working of the Bookstall are paid to the Imperial College Union Council for general student purposes.*

The Imperial College Students' Library is situated in the Unwin Building of the City and Guilds College and is controlled by a Library Committee consisting of a chairman and two members from the I.C.U. Council, one member from the Literary and Debating Society, and one member from the Musical and Dramatic Society.

Imperial College Clubs and Societies.—These Clubs and Societies are financed by the Imperial College Union Council who give a grant to each of the sub-committees set up to control the Clubs and Societies, viz. the Imperial College Union Athletic Clubs Committee and the Imperial College Union Social Clubs Committee.

Each Committee consists of one representative of each Club and Society, together with the President and Honorary Secretary of the I.C. Union, and an Honorary Treasurer.

The Imperial College Athletic Clubs are :—

Imperial College Association Football Club.*
Imperial College Athletic Club.*
Imperial College Badminton Club.*
Imperial College Boat Club.*
Imperial College Boxing and Gymnastic Club.*
Imperial College Cricket Club.*
Imperial College Cross Country Club.*
Imperial College Fencing Club.*
Imperial College Golfing Association.*
Imperial College Hockey Club.*
Imperial College Judo Club.*
Imperial College Lawn Tennis Club.*
Imperial College Rifle Club.*
Imperial College Rugby Football Club.*
Imperial College Sailing Club.*
Imperial College Squash Racquets Club.*
Imperial College Swimming Club.*
Imperial College Table Tennis Club.*
Imperial College Women's Sports Club.*

The Imperial College Social Clubs are :—

Imperial College Arab Society.
Imperial College Bridge Club.
Imperial College Catholic Society.
Imperial College Chess Club.
Imperial College Dancing Club.
Imperial College Dramatic Society.
Imperial College Film Society.
Imperial College Gliding Club.*
Imperial College Ice-Skating Club.*
Imperial College Jazz Club.
Imperial College Jewish Society.
Imperial College Library.
Imperial College Literary and Debating Society.
Imperial College branch of the London Inter-faculty Christian Union.
Imperial College Mountaineering Club.
Imperial College Musical Society.
Imperial College Photographic Society.
Imperial College Political Society.
Imperial College Railway Society.
Imperial College Riding Club.
Imperial College Rover Crew.
Imperial College Ski Club.
Imperial College Branch of Student Christian Movement.
Imperial College Branch of the Youth Hostels Association.

Each of these Clubs and Societies is managed, as regards its internal affairs, by its own officers and committees, elected by the active members of the Club or Society.

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* These clubs require additional fees from members.

Full and Half Colours are awarded by the Captains of the respective Athletic Clubs, subject to the approval of the I.C.U. Athletic Clubs Committee, at the end of the season. The Full Colour takes the form of a tie, in I.C. colours, and a royal blue blazer piped in grey. The year of the award, together with the initials of the Club is added in gold below the crest on the pocket. The Half Colour takes the form of a tie and a similar blazer as for the Full Colour but without the piping.

Colours are also awarded by the Presidents of certain of the Social Clubs who partake in competitive activities, subject to the approval of the I.C.U. Social Clubs Committee. This Colour takes the form of a maroon tie bearing the I.C. crest.

In the final term a small number of Union Awards is made to full members of I.C.U. whose outstanding services to the Union have not necessarily been recognised in any other way. This award takes the form of Laurel Leaves placed below the I.C. crest on the College blazer.

Membership of all Imperial College Clubs and Societies is open directly to all members of the Imperial College Union. In some cases there is an additional subscription, but in most cases this subscription is small.

Dances and other social functions are arranged by the Imperial College Entertainments Committee which is a sub-committee of the I.C.U. Council.

Members are encouraged to belong to one or more of the above clubs and societies as the social life of the College is centred round the activities of these bodies. It is expected that members should belong to I.C. Clubs in preference to outside clubs. In most cases it is difficult to find better facilities elsewhere.

The Phoenix is the Imperial College magazine which contains news and reports of the activities of the above Clubs as well as articles, and appears three times a year. Contributions should be sent to the Editor at the Imperial College Union.

Felix is the Union's fortnightly newspaper, price 3*d*.

The Imperial College Athletic Ground completed in 1939 is situated in Sipson Lane, Harlington, Middlesex.

The ground is provided with a pavilion giving adequate refreshment, dressing room and bathing facilities and is in charge of a resident groundsman.

A coach is run every Wednesday and Saturday, to convey members from the Union to the ground, and back after the game.

The control of the Athletic Ground is vested in the Athletic Ground Committee, comprising one student and one member of staff from each of the constituent colleges, the President of the Union, the Chairman of the Athletic Clubs' Committee and one student representative from Council.

Imperial College Boat House, built in 1938, is situated on the Thames Embankment at Putney, adjoining that of Thames Rowing

Club. It incorporates all the latest features of design including an upstairs room for tanking and commands a good view over the Putney reach.

STUDENTS' INDIVIDUAL COLLEGE UNIONS

Each of the three College Unions has its own Officers and Committee. The Officers include a President, one or more Vice-Presidents, and an Honorary Secretary, who are elected by a General Meeting of the Union. A member of the Academic Staff of the corresponding College is elected or co-opted as Honorary Treasurer. Each Union Committee consists of representatives (usually the principal officers) of the chief Clubs and Societies in the Union, and representatives elected by and from students of different years in the corresponding College.

Each Union entertains its Freshmen to dinner at the beginning of the College session, and the respective Entertainments Committee organises social functions, such as dances, carnivals, etc., for its members during the session.

The following Clubs and Societies are financed and controlled by the individual College Union Committees :—

Royal College of Science Union	Royal School of Mines Union	City and Guilds College Union
R.C.S. Association Football Club	R.S.M. Association Football Club	C. and G. Association Football Club
R.C.S. Athletic Club	R.S.M. Athletic Club	C. and G. Athletic Club
R.C.S. Badminton Club	R.S.M. Boat Club	C. and G. Boat Club
R.C.S. Boat Club	R.S.M. Boxing Club	C. and G. Boxing Club
R.C.S. Boxing and Gymnastic Club	R.S.M. Hockey Club	C. and G. Dancing Club
R.C.S. Hockey Club	R.S.M. Lawn Tennis Club	C. and G. Hockey Club
R.C.S. Lawn Tennis Club	R.S.M. Rifle Club	C. and G. Motor Club
R.C.S. Rifle Club	R.S.M. Rugby Football Club	C. and G. Rifle Club
R.C.S. Rugby Football Club		C. and G. Rugby Football Club
		C. and G. Lawn Tennis Club
Imperial College Chemical Society	R.S.M. Mining and Metallurgical Society	C. and G. Engineering Society
R.C.S. Journal Board		C. and G. Radio Society
R.C.S. Mathematical and Physical Society		Imperial College Chemical Engineering Society and Journal Board
R.C.S. Natural History Society		

Each of these Clubs and Societies is managed, as regards its internal affairs, by its own officers and committee elected by the active members of the Club or Society.

The Clubs devoted to sport arrange inter-College matches and fixtures with outside clubs. The Colleges enter separate teams for the "Engineers' Cup" (Rugby Football) (between R.S.M. and C. & G. only) "Sparkes' Cup" (Rugby Football) (between R.S.M., C. & G. and R.C.S.) and for the "Technology Cup" (Association Football), and compete with one another in the race for the "Morphy Cup" and "Lowry Cup" (Rowing) and also for the "Governors' Shield" and "Rector's Cup" (Athletic Sports), also an Inter-College Challenge Cup presented by Dr. Sparkes, 1951. Inter-College boxing and tennis, etc., are also organised. Rivalry between the three Colleges in these sports does much to promote the efficiency of the corresponding Imperial College Clubs. The award of Colours for the various sports is made by the Union Committees on the recommendation of the Captains of the corresponding Clubs.

The activities of the Scientific and Technical Societies include meetings at which papers are read by members or by specially invited lecturers; discussions; visits to works, research stations, etc. The Societies in the R.C.S.U. publish conjointly the "Scientific Journal of the Royal College of Science."

The Imperial College Chemical Engineering Society, and the Royal School of Mines' Mining and Metallurgical Society also publish journals.

Details of the activities of Clubs and Societies are set out, in some cases, in booklets issued by the College Unions to their members at the beginning of the College session, and notices of matches, meetings, etc., are posted on the boards in the various College Entrance Halls and also, in some cases, on the various notice boards allocated for that purpose in the Entrance Hall of the Imperial College Union Building.

Students wishing to particpate in the activities of any particular Club or Society, or to get further information regarding such activities, should apply to the Honorary Secretary of the Club or Society in question.

The Colours of the Colleges are :—

R.C.S.—Black, White and Purple.

R.S.M.—Gold, Silver and Black.

C. and G.—Red and Silver.

and are classified as follows : (*a*) General Colours, which may be worn by any member of the Union ; (*b*) Full and Half Colours, which may be worn only by members to whom they have been awarded. Blazers, ties, scarves, etc., in the Colours of the Colleges, articles bearing the College crests, and special College note-paper can be obtained from the Imperial College Bookstall.

IMPERIAL COLLEGE UNION VACATION WORK SCHEME

This scheme is controlled by a Committee consisting of one technical representative from each department of the College, and two student members, elected by I.C.U. Council, under the Chairmanship of Professor H. Levy, who is the representative of the Governing

Body. Mr. J. Newby, Superintendent of Vacation Studies, acts as Secretary to the Vacation Work Committee, to whom all communications should be addressed.

The objects of the scheme are to provide students of the Imperial College with practical experience at home and abroad under industrial conditions during vacations, and to assist them generally in making useful contacts with industry.

Under certain conditions students who have been accepted for admission may register with the Scheme for the purpose of obtaining practical experience during the vacation period immediately prior to admission to the College.

IMPERIAL COLLEGE BOOKSTALL

The Bookstall is in the Beit Building, where all text-books, instruments, stationery, sports clothes, etc., required by students can be obtained.

HOSTEL AND LODGINGS

(*a*) *Lodgings.* Students requiring accommodation can apply to the University of London Lodgings Bureau, but enquiries should in the first instance be sent to the Registrar of the College.

(*b*) *Hostel.* Information regarding the College Hostel is given in the Prospectus. Applications for admission should be addressed to the Hostess.

Dean of Residents : D. N. de G. Allen, Esq., M.A.

Hostess of the Hostel : Miss C. Sherwood.

ROYAL NAVAL VOLUNTEER RESERVE

The London Division of the R.N.V.R. situated in H.M. Ships *President* and *Chrysanthemum* near Blackfriars Bridge provides naval training facilities for students and others both before and after their period of whole time National Service.

Within the limits of the small number taken for National Service in the Royal Navy each year, training facilities exist for all branches of the Naval Service. With the principal exception of students who will graduate in Mechanical and Electrical Engineering, it is essential to join the R.N.V.R. at least one year prior to call up for National Service.

For University students who have joined the R.N.V.R. provision is made for automatic appearance before Officer Selection Boards either before, or shortly after, call-up and in the case of engineer graduates whether or not they have already joined the R.N.V.R. they will only be accepted for National Service in the R.N. after a Selection Board has been satisfied that a commission would be appropriate.

The obligations for training in the R.N.V.R. need not exceed a three week course in the vacation during the first year of enrolment, and a two week period in subsequent years. These special provisions

for University Students are minima and can be augmented by weekly attendance as for normal enrolments.

In addition to normal training, facilities exist for :—

(*a*) Week-end cruises in minesweepers attached to *President*.

(*b*) Boat sailing.

(*c*) Rifle shooting from R.N.V.R. establishment at Bisley.

(*d*) Social activities, dances, etc.

(*e*) Football, boxing, fencing, boat pulling, etc.

Bounty is payable annually, travelling and training allowances are payable quarterly, and normal naval rates of pay apply for periods of training in excess of 8 hours.

Further information may be obtained by application either by post to the Commanding Officer,

H.M.S. President, Kings Reach, London, E.C.4.

or by personal appearance, from the Recruiting Officer on any Wednesday evening. Telephone : CENtral 3309.

UNIVERSITY OF LONDON U.T.C. (T.A.)

The University Training Corps is established to provide basic military training for students who have had their whole-time Military Service deferred, and to develop a capacity for leadership in them in order to assist them in their subsequent military service. In addition, specialist Arms Training is given to those students who wish to enter a particular Arm of the Service when called up. These Arms are at present, Royal Artillery, Royal Engineers, Infantry, Royal Signals, Royal Army Medical Corps, Royal Electrical and Mechanical Engineers, and Intelligence Corps.

Commanding Officer : Lt.-Col. R. L. Stear, T.D.

Adjutant : Major A. R. Carter (Royal Artillery).

Students who have already completed their two years' whole-time National Service and are committed to $3\frac{1}{2}$ years' part-time service with the Territorial Army are entitled to volunteer to serve in the U.T.C. In many cases, this would be of advantage to students in view of the fact that parades and Camps in the U.T.C. are arranged so as not to conflict with academic commitments in the University.

The Training Corps forms part of the Territorial Army, and the following military benefits are therefore offered :—

(*a*) Time served by deferred students with the U.T.C. earns remission of post full-time National Service.

(*b*) Direct entry to Officer Cadet Training Unit on call-up for suitable candidates.

(*c*) Territorial Army Commissions for suitable candidates whilst serving with the U.T.C.

(*d*) Pay and allowances at the normal Territorial Army rates for attendance at parades and camps.

(*e*) An Annual Bounty of £12 granted to all cadets who carry out the training commitment of 30 hours' evening parades and 15 days' camp during the year, and who have reached a reasonable standard of efficiency.

(*f*) All travelling expenses refunded.

(*g*) Free uniform and equipment.

In addition, the Headquarters of the Corps is equipped for social functions. A Club Room with a Bar, radio, indoor games, etc., is provided.

Students aged 17 years or over, and who are medically fit, are eligible for membership.

Full details regarding service in the Corps may be obtained from the Adjutant, University of London U.T.C. (T.A.), Imperial Institute, South Kensington, S.W.7. Telephone : KENsington 2482-3.

UNIVERSITY OF LONDON AIR SQUADRON

The Squadron provides flying training for internal students of the University of London and provides facilities to members who wish to make the Royal Air Force their career.

Membership is open to the following :—

(*a*) Pre-National Service Undergraduates who will be trained up to the R.A.F. basic stage before National Service with the R.A.F. Flying training will be continued during actual service with the R.A.F.

(*b*) Any ex-member of the Royal Air Force.

(*c*) Any ex-member of the R.N.V.R. or Army until such time as they leave, after National Service, with a definite reserve liability to their parent Service.

The lower age limit is 17 and the upper 30 years.

The syllabus of ground and air training is so arranged as not to interfere with academic studies and adequate allowances are paid to cover all expenses. A further retaining fee of £35 is paid annually to all those who successfully complete the syllabus.

A Fighter Control Flight has now been formed in the Squadron and membership is open to men and women in the following categories :—

(*a*) Those with no previous service.

(*b*) Those with previous service as airmen or airwomen.

(*c*) Those with previous service as officers but with no Fighter Control experience.

(*d*) Those with previous R.A.F. service as officers in the branch of Fighter Control (including the wartime branches of Operations Room G, i.e., Filter officer and Interception Controller).

Syllabus of ground training arranged so as not to interfere with academic studies. Adequate allowances paid to cover all expenses.

Club facilities are provided at the Town Headquarters and at Booker where the flying is carried out.

Further information can be obtained on application to The Secretary, University of London Air Squadron, 48, Princes Gardens, London, S.W.7. (Telephone : Kensington 6762.)

OLD STUDENTS' ASSOCIATIONS

The Royal College of Science Association

(Old Students and Staff)

This Association was formed in 1908 under the presidency of the late Mr. H. G. Wells. Membership is open to all old students of the Royal College of Science, to present students doing third year or postgraduate work at the College, and to members of the staff of the Royal College of Science. Its main objects are to keep old students in touch with the College, to safeguard and promote their interests, the interests of the College and of other federated Colleges of the Imperial College of Science and Technology, and to promote social intercourse among the members. The present membership is over 1,200.

The principal social event organised by the Association is the Annual Dinner and Dance. Informal evening functions are held from time to time and include a reception in the Imperial College Union after the Annual General Meeting. Luncheons are held in the West End about once every three months. A magazine, "The Record," is issued two or three times a year. In 1951 a new edition of the Register of Old Students and Staff of the R.C.S. was published.

The minimum annual subscription is 10*s*. (except that student members are admitted at 5*s*. per annum during the first three years of eligibility).

President : F. P. Dunn, A.R.C.S., D.I.C., F.R.I.C.

Hon. Treasurer : H. N. Rydon, D.Sc., A.R.C.S., D.I.C.

Hon. Secretary : B. Atkinson, Ph.D., A.R.C.S., D.I.C., Royal College of Science, South Kensington, S.W.7.

The Royal School of Mines Association

President : V. Harbord, A.R.S.M., F.R.I.C., M.I.M.M.

Hon. Secretary-Treasurer : J. H. Watson, M.B.E., M.C., Ph.D., A.R.S.M., M.I.M.M., Royal Mint, London, E.C.3.

This Association dates from the early days of the Royal School of Mines, when an annual gathering of old students was held to do honour to individuals eminent in the sphere of Mining or of Mining Education. In 1913 it was put on a more definite basis with the objects, in addition to those already established, of representing the corporate views of the old students and of furthering the interests of the School. The executive of the Association consists of a President, a General Committee, and an Honorary Secretary-Treasurer. The necessary funds are provided by an annual subscription of half-a-guinea, or a life subscription of five guineas ; for the first two years after leaving the School, members are admitted free. The present membership is about 600.

In the year 1920 the Association published in one volume a History of the School and a Register of Old Students ; the Register was revised and brought up to date in 1932. The latest edition of the Register is " The 1947 Register."

In matters concerning all three Colleges of the Imperial College, the Association acts in conjunction with the Old Students' Associations of the other two Colleges.

The South African Association, with its headquarters at Johannesburg, is now the South African Branch of the R.S.M. Association :—

Chairman : W. E. Gooday, A.R.S.M., D.I.C., M.I.M.M.

Hon. Secretary : G. F. Hatch, A.R.S.M., A.M.I.M.M., 733, " Libertas," 62, Marshall Street, Johannesburg.

The Trinidad Branch, with its headquarters at Point Fortin, was formed this year :—

Chairman : W. E. Madden, A.R.S.M., A.M.Inst.P.T.

Hon. Secretary : W. T. Pickard, B.Sc., A.R.S.M., c/o U.B.O.T. Ltd., Point Fortin, Trinidad, B.W.I.

R.S.M. visitors or arrivals in either of these two centres are cordially invited to communicate with the Honorary Secretary concerned.

The Old Centralians Association

President : E. M. Rich, C.B.E., F.C.G.I., F.C.S., B.Sc.

Hon. Secretary : A. M. Holbein, C.B.E., F.C.G.I., M.I.C.E., B.Sc.(Eng.), D.I.C., 3, St. James's Square, London, S.W.1.

The Central Technical College Old Students' Association was founded in July, 1897, its objects being to maintain connection between past students and the College, and to further their interests. To promote these objects the Association established, in 1904, its journal " The Central," since published twice yearly. In order to perpetuate the original name of the College and to provide a title appropriate to all former students, the name of the Association was changed in 1912 to the " Old Centralians."

The Association holds meetings of varying character throughout the year. These include the Annual Dinner ; the Annual General Meeting (at which an address is given by some person of eminence connected with engineering), followed by buffet supper at the Imperial College Union ; discussions on subjects of direct interest to members ; informal monthly luncheons ; and formal and informal dances. The 1951 Annual Dinner was held in Grocers' Hall in November. A Ball was held at Ironmongers' Hall in June.

The Association maintains an Employment Register available to all Old Centralians, which co-operates with the Imperial College Appointments Board, and deals more particularly with old students who have left the College for some years. A special effort has been made to find civilian employment for those Centralians who have been demobilised from the Services.

The Association, through its nominees on certain committees of the Imperial College and of the City and Guilds of London Institute,

supports the work of these organisations. It also co-operates with the Old Students' Associations of the other constituent colleges in matters of common interest.

There are four provincial centres and four overseas branches, of the Old Centralians, which also hold dinners and luncheons at various times during the year :—

Northern Branch (Manchester)—

Chairman : R. R. Whyte, M.B.E., A.C.G.I., B.Sc.

Hon. Secretary : D. J. Kingsbury, A.C.G.I., B.Sc., D.I.C., 10, Egerton Road, Chorlton-cum-Hardy, Manchester, 21.

North-East Coast (Newcastle-on-Tyne)—

Chairman : E. Fawssett, F.C.G.I., M.I.E.E.

Hon. Secretary : C. G. Giles, A.C.G.I., M.I.E.E., 28, Crossway, Jesmond, Newcastle-on-Tyne.

Midland Branch (Birmingham)—

Chairman : R. A. Wilson-Jones, A.C.G.I., B.Sc., M.I.Mech.E.

Hon. Secretary : A. A. Blanco, B.Sc. (Eng.), 99, Middleton Hall Road, Kings Norton, Birmingham.

South-Western Branch (Bristol)—

Chairman : J. Rosen, F.C.G.I., B.Sc., M.I.C.E., M.I.E.E.

Hon. Secretary : A. Cadman Clinton, F.R.Ae.S., The Chalet, Alveston, Nr. Bristol.

Buenos Aires Branch—

Chairman : R. W. Peake, A.C.G.I., D.I.C., B.Sc.

Hon. Secretary : R. Hufnagel, 25, de Mayo 347, Office 312, Buenos Aires, Argentine.

Calcutta Branch—

Chairman : E. W. Cosserat, M.I.R.S.E.

Hon. Secretary : K. L. De, A.C.G.I., B.Sc. (Eng.)., 79, Cornwallis Street, Calcutta.

Bombay Branch—

Chairman :

Hon. Secretary : J. B. Bharucha, c/o Associated Cement Co., Ltd., Queen's Road, Bombay.

Rhodesias Branch—

Chairman : A. C. Selby, A.C.G.I., A.M.I.C.E.

Hon. Secretary : P. W. Kennedy, A.C.G.I., A.M.I.C.E., A.M.I.Mech.E., P.O. Box 250, Fort Victoria, S. Rhodesia.

South African Branch—

Chairman :

Hon. Secretary : L. H. L. Badham, P.O. Box 67, Germiston, Transvaal.

Past students of the City and Guilds College ; present second and third year students and past and present members of the College Staff ; and past students of the former City and Guilds Technical College, Finsbury (closed 1925) are eligible for membership. The annual subscription is 10*s.* 6*d.* (reduced for young members). Particulars can be obtained from :—

Hon. Secretary and Treasurer : A. M. Holbein, C.B.E., F.C.G.I., M.I.C.E., B.Sc.(Eng.), D.I.C., 3, St. James's Square, London, S.W.1. (Telephone : Trafalgar 7833.)

The Deputy Registrar : John Walker, City and Guilds College, Exhibition Road, South Kensington, London, S.W.7. (Telephone : Kensington 4861.)

Information about the Employment Bureau may be obtained from E. E. Butten, A.C.G.I., B.Sc.(Eng.), F.I.I.A., 55, South Audley Street, London, W.1. (Telephone : Grosvenor 4591.)

NOTES FOR STUDENTS

Students are asked to co-operate with the College Authorities by attention to the following :—

1. A student admitted to any course of study must attend to the satisfaction of the Head of his Department.

2. The normal College hours are from 10 a.m. to 5 p.m. on five days a week, Mondays to Fridays. Formal permission is not required for occasional absence, but, as an act of courtesy, the lecturer in charge should, when possible, be informed prior to such absence.

3. If absence from College is foreseen, the student should, as a matter of courtesy, inform the members of Staff concerned.

4. Unforeseen absence of more than a day, through illness or other cause, should be notified to the Registrar as soon as possible with an indication of the period likely to be involved. When absence on account of illness exceeds one week, or involves the missing of part or the whole of an examination, a medical certificate should be sent at once to the Registrar.

5. Students who contract an infectious or contagious disease, or who live in a house in which a case of such disease occurs, must absent themselves from College and notify the Registrar immediately. They must not resume attendance until they have presented a medical certificate that it is safe for them to do so.

6. Students should notify the Registrar of any change in their home or lodgings address.

7. Students are personally responsible for entry forms and fees for University Examinations being sent to the University by the specified dates. Particulars will be posted in College Halls for the information of students. Application for University registration and entry forms should be made to the College Registry.

8. Smoking is normally prohibited, but relaxation of this rule is permitted in certain parts of the buildings, on the authority of the Head of Department concerned.

9. Lockers are provided and each student should obtain from the Registry a locker key, which will be charged against the student's breakage deposit if not returned. All personal possessions not in use should be kept in a locker. The College Authorities accept no liability for loss of property either from a locker or any other part of the College premises.

10. The College Authorities accept no liability for accidents to students while pursuing any part of their course or during games, and they recommend that students should take steps to insure themselves against accidents.

11. Discipline is under the control of the College Authorities, who may in the case of serious offences suspend a student from attendance or expel him.

SCHOLARSHIPS, PRIZES, &c., AVAILABLE TO STUDENTS OF THE COLLEGE

Undergraduate Awards

Baker Prize for Analytical Chemistry.—Value £2 for books. Awarded on Final Examinations in Chemistry.

Bennett H. Brough Medal and Prize.—Value approx. £3 for medal and books. Awarded for excellence in Mine Surveying to an Associateship student in Mining or Mining Geology.

Bessemer Medal and Prize.—Value approx. £5 for medal and books. Awarded for highest marks in Metallurgy (including Assaying) in Finals for Associateship in Metallurgy.

Bramwell Medal and Unwin Premium.—Awarded to the student at the top of the Final class list in Mechanical Engineering.

British Society of Mining Students' Prize.—Value approx. £6. Awarded to the Royal School of Mines student obtaining highest marks in Principles of Mining and Mining Economics.

Charleton Prize.—Value approx. £21. Awarded by the Institution of Mining and Metallurgy on the recommendation of the College to a 2nd or 3rd year Royal School of Mines student for all-round excellence.

Clement Le Neve Foster Prize.—Value approx. £38. Awarded for excellence in Geology, Mineralogy or Mining, to a student in his final year at the Royal College of Science or Royal School of Mines. For books or instruments, or to aid in research approved by the College.

Cullis Testimonial Fund.—Value £5. To assist Mining Geology students.

David Salomons and David Hughes Scholarships.—Value £50 each. Awarded by the Institution of Electrical Engineers for Course in Electrical Engineering. The City and Guilds College is one of the Colleges invited from time to time to make nominations.

De La Beche Medal.—Awarded to the best student in Mining.

Edmund White Prize for Organic Chemistry.—Value £25. Awarded for excellence in Organic Chemistry in the third year.

Ernest Edward Glorney Scholarship.—Value approx. £38. Awarded for excellence in Mining and/or Metallurgy to a student completing Finals in either of these subjects. The Scholarship may be used (*a*) to study for another year at the College ; (*b*) to obtain practical training after leaving College ; or (*c*) to travel so as to obtain professional experience.

Faber Prize.—Value £6. Offered annually for the best student paper presented before the City and Guilds College Engineering Society.

Finsbury Medal.—Awarded to the undergraduate student of greatest merit in aeronautical engineering.

Forbes Memorial Medal and Prize.—Value approx. £14 for medal and books. Awarded to a student taking Finals in Botany or Zoology.

Frank Hatton Prize.—Value approx. £5 for books. Awarded for proficiency in Advanced Chemistry in the Final year in Chemistry.

Governors' Prizes.—Value £3 each, for books. Awarded to the best student in Mathematics, Physics, Practical Chemistry, and Mining, at the Final examinations in these subjects.

Henrici Medal and Premium.—Awarded to the student of greatest merit in Mathematics taking Finals at the City and Guilds College.

Hinchley Medal.—Awarded by the Institution of Chemical Engineers to the student of greatest merit at the Final examinations in Chemical Engineering.

Hofmann Prize.—Value £2 2*s.* for books. Awarded by the Hofmann Society for excellence in Organic Chemistry at the Final examination in Chemistry.

Imperial College Scholarships and Exhibitions.—Value : Scholarships—full fees, Exhibitions—half fees. Undergraduate students are considered for awards on their work at College. Awards are tenable for completion of Associateship course and in some circumstances for one year of postgraduate study.

Institute of Petroleum Prize.—Value £50. Awarded by the Institute, on the recommendation of the College, to a 1st or 2nd year student of the Oil Technology Department who is a student member of the Institute, to assist him with his 2nd or 3rd year studies.

John Samuel Scholarship.—Value £32 and free place. Awarded to a meritorious student on the completion of Part I, Engineering. Tenable for one year.

Murchison Medal and Prize.—Value £14 for medal, books and instruments. Awarded to Royal College of Science or Royal School of Mines student for proficiency in Geology Part I.

Perry Memorial Medal and Prize.—Value approx. £2 for medal and books. Awarded to a student of the Royal School of Mines who obtains a first class in Mechanics, Part I. Account is taken of work in Mathematics, Mechanics, Graphics and Applied Electricity.

Siemens Memorial Medal and Premium.—Awarded to the student at the top of the Final class list in Electrical Engineering.

Sir Arthur Acland English Essay Prize.—Value 25 guineas. Open to students studying for an Associateship. Candidates must submit an English Essay on any subject except a specialised technical subject. Notice of Competition will be posted in the College.

Tyndall Prize.—Value approx. £4 for books. Awarded to the most proficient student in Practical Physics at the Final Examinations.

Unwin Medal and Premium.—Awarded to the student at the top of the Final Class List in Civil Engineering.

Watts Medal.—Awarded on the Final examinations held in the Geology Department (Geology, Mining Geology or Oil Technology).

Postgraduate Awards

Edmund White Prize for Research in Organic Chemistry.—Value £25. For award to the student who has not yet received a higher degree and who has shown most promise in research.

Huxley Memorial Medal and Prize.—Value approx. £58 for medal, with balance for books and instruments, or towards research. For award to a student or former student for ability to carry on research in Natural Science.

John and Frances Jones Scholarship.—Value approx. £42. For award to a member or descendant of a member of the City and Guilds Old (Centralians) Students' Association for a post-graduate course at the City and Guilds College.

Judd Prize.—Value approx. £6, to aid research. For award to an Associate for original work done in the Geology Department.

Marshall Scholarship.—Value approx. £36. For award for research in Biology (including Palaeontology) to a student who has completed at least one year in the College.

Matthey Prize.—Value approx. £27, for books, instruments or otherwise. For award to an Associate of the Royal School of Mines for research completed in the Metallurgy Department.

Old Students' Royal College of Science Research Scholarship in Botany.—Value £100 for one year. For award to a student who has spent at least one year in the Botany Department, to undertake research in Botany with a view to a Doctorate.

Unwin Scholarships (two).—Value approx. £50 each. Awarded annually—amount divided equally between a student of the Department of Civil Engineering and a student of the Department of Mechanical Engineering, at the conclusion of their courses, preferably postgraduate.

Warington Smyth Medal and Prize.—Value approx. £45. For award to an Associate with First Class in Mining who has also obtained First Class in Metallurgy, Geology or Mechanics during the Mining course. Candidates are required to submit an essay by 1st June.

(*Note.—Information regarding postgraduate awards available to other students—as well as those at the College—is given in the Prospectus obtainable on application to the Registrar.*)

EXAMINATIONS

ROYAL COLLEGE OF SCIENCE

	Degree Exam. for which recognised.	*Date*
INTERMEDIATE YEAR		
Physics I (Th. & Pr.)	Inter.	February
Pure Mathematics (M.1)	,,	,,
Applied Mathematics (M.2)	,,	June
Chemistry I (Th. & Pr.)	,,	,,
FIRST YEAR		
Botany Students :		
Zoology I (Th. & Pr.)	Ancillary	February
Geology I (Th. & Pr.)	,,	June
Botany I (Th. & Pr.)	—	,,
Chemistry (Th. & Pr.)	Ancillary	,,
Chemistry Students :		
Organic Chemistry (Th.)	—	June
Physical Chemistry (Th.)	—	,,
Inorganic Chemistry (Th. & Pr.)	—	,,
Mathematics	Ancillary	,,
Physics	,,	,,
Geology Students :		
Biology	Ancillary	February
Topographical Surveying (Th.) (Min. 6)	—	,,
Geology I (Th. & Pr.)	—	June
Physical Chemistry (C.114)	—	,,
Mathematics Students :		
Applied and Practical Mathematics (M.9)	Final	February
Statistics and Practical Mathematics (M.11 and 12)	,,	,,
Pure Mathematics (M.16)	,,	,,
Applied Mathematics (M.8 and M.10)	,,	June
Practical Mathematics (M.13 and M.14)	,,	,,
Pure Mathematics (M.16)	,,	,,
Physics Students :		
Applied and Practical Mathematics (M.9)	Ancillary	February
Statistics and Practical Mathematics (M.11 & M.12)	,,	,,
Pure Mathematics (M.6)	,,	February and June
Physics (Th. & Pr.)	Final	June
Zoology Students :		
Zoology I (Th. & Pr.)	Ancillary	February
Botany I (Th. & Pr.)	,,	,,
Geology I (Th. & Pr.)	,,	June
SECOND YEAR		
Botany Students :		
Chemistry (Th. & Pr.)	Ancillary	February
Botany (Th.)	Final	June
Botany (Pr.)	,,	,,
Chemistry Students :		
Inorganic Chemistry (Th. & Pr.)	Final	February
General and Physical Chemistry (Th.)	,,	,,
Physical Chemistry (Th.)	,,	,,
Organic Chemistry (Th. & Pr.)	,,	June
Geology Students :		
Mining Geology, 1st Course (Th.)	Final	February
Palæontology (Th. & Pr.)	,,	June
Physical Geology (Th.)	,,	,,
Mineralogy (Th. & Pr.)	,,	,,
Structural Geology	,,	,,
Mathematics Students :		
Applied Mathematics (M.17, 18)	Final	February
Pure Mathematics (M.23)	,,	,,
Applied Mathematics (M.19)	,,	June
Pure Mathematics (M.23)	,,	,,
Problem Paper (Pure Maths.)	,,	,,
Practical Mathematics (M.14)	,,	,,

EXAMINATIONS—*continued.*

SECOND YEAR R.C.S.—continued

	Degree Exam. for which recognised.	*Date*
Physics Students :		
Mathematics (M.24)	—	February
Physics (Th. & Pr.)	Final	June
Zoology Students :		
Zoology (Th. & Pr.)	Final	June
Botany (Th. & Pr.)	,,	,,
Plant Physiology and Plant Pathology (Th. & Pr.)	,,	,,

THIRD YEAR

Botany Students :		
Botany (Th.)	Final	June
Botany (Pr.)	,,	,,
Geology Students :		
Petrology (Th. & Pr.)	Final	June
Stratigraphy (Th. & Pr.)	,,	,,
Mining Geology, 2nd Course (Th. & Pr.) (or other approved course)	,,	,,
Mathematics Students :		
Applied Mathematics (M.20, 21, 22)	Final	February
Essay Paper	,,	June
Zoology Students :		
Zoology and/or Entomology (Th. & Pr.)	Final	March
Essay Paper	,,	June

ROYAL SCHOOL OF MINES

INTERMEDIATE YEAR

Physics I (Th. & Pr.)...	Inter.	February
Pure Mathematics (M.1)	,,	,,
Applied Mathematics (M.2)	,,	June
Chemistry I (Th. & Pr.)	,,	,,
Principles of Machines	—	,,

FIRST YEAR

All Students (other than Mining Geology) :		
Applied Mathematics (M.4)	Inter.	February
Engineering Drawing and Design (1st yr. Met. and Min.)	Final	,,
Graphics	—	,,
Applied Mechanics (Min. 2)	—	,,
Applied Mathematics (M.4)	—	June
Geology I	Ancillary	,,
Applied Electricity (1st yr. Met. and Min.) ...	—	,,
Physical Chemistry (C.113) (1st yr. Met.) ...	—	,,
Physical Chemistry (C.114) (1st yr. Oil)	—	,,
Mining Geology Students :		
Topographical Surveying (Th.)	Final	February
Assaying (Th. & Pr.)...	,,	,,
Geology I (Th. & Pr.)	Ancillary	June
Physical Chemistry (Th.) (C.114)	—	,,

SECOND YEAR

Metallurgy Students :		
Assaying (Th. & Pr.)	Final	February
Metallurgy (Non-Ferrous) (I) (Th.)	,,	,,
Mineral Dressing (Th.)	,,	,,
Metallurgy (Ferrous) (Th.)	,,	June
Fuel and Thermo-Metallurgy (Th.)	,,	,,
Refractory Materials...	,,	,,
Physical Metallurgy I (Th. & Pr.)	,,	,,

EXAMINATIONS—*continued.*

SECOND YEAR R.S.M.—continued

	Degree Exam. for which recognised.	*Date*
Mining Students :		
Power Generation	Final	February
Topographical Surveying	,,	,,
Mining Geology, 1st Course (Th.)	,,	,,
Principles of Mining	,,	June
Electrical Engineering	,,	,,
Materials and Structures	,,	,,
Mining Machinery	,,	,,
Mining Geology Students :		
Stratigraphical Palæontology	Final	February
Mining Geology, 1st Course (Th.)	,,	,,
Mineralogy (Th. & Pr.)	,,	June
Petrology (Th. & Pr.)	,,	,,
Mining Geology, 2nd Course (Th. & Pr.) ...	,,	,,
Structural Geology	,,	,,
Oil Technology Students :		
Physical Geology	Final	June
Structural Geology	,,	,,
Palæontology (Th. & Pr.)	,,	,,
Properties of Petroleum and Oilfield Fluids (Th. & Pr.)	,,	,,
Sedimentary Petrology (Th. & Pr.)...	,,	,,

THIRD YEAR

Metallurgy Students :		
Metallurgical Analysis (Th. & Pr.)	Final	February
Mechanical Treatment and Testing	,,	,,
Non-Ferrous Metallurgy II	,,	June
Physical Metallurgy II	,,	,,
Metallurgy (Pract.)	,,	,,
Mining Students :		
Mineral Dressing (Th.)	Final	February
Metallurgy (Th.)	,,	,,
Assaying (Th. & Pr.)...	,,	,,
Mining Economics	,,	June
Mine Surveying	,,	,,
Mining Geology Students :		
Geophysical Prospecting (Th.)	Final	February
Principles of Mining	,,	June
Mining Economics	,,	,,
Mine Surveying	,,	,,
Physical Geology (Th.)	,,	,,
Oil Technology Students :		
Topographical Surveying (Th.)	Final	February
Geology of Petroleum (Th.)	,,	June
Structural Geology of Petroleum (Th. & Pr.) ...	,,	,,
Oilfield Drilling (Th.)	,,	,,
Principles of Geophysical Prospecting	,,	,,

CITY AND GUILDS COLLEGE

FIRST YEAR

Aeronautical, Civil, Electrical and Mechanical Engineering Students :		
Mathematics (2 papers)	Final, Part I	June
Applied Mechanics (I and II)	,,	,,
Applied Heat	,,	,,
Engineering Drawing	,,	,,
Applied Electricity	,,	,,
Chemical Engineering Students :		
Organic Chemistry	Final, Part I	June
Engineering Drawing	,,	,,
General and Physical Chemistry (2 papers) ...	,,	,,
Mathematics (2 papers)	,,	,,

EXAMINATIONS—*continued*

	Degree Exam. for which recognised.	*Date*
C. & G.—continued		
SECOND YEAR		
Chemical Engineering Students :		
Mathematics (1 paper)	Final, Part I	June
Engineering I (Materials and Theory of Machines)	,,	,,
Engineering II (Applied Thermodynamics) ...	,,	,,
Engineering III (Fluid Mechanics and Metallurgy)	,,	,,
Applied Electricity	,,	,,
Heat Transfer...	,,	,,
Civil Engineering Students :		
Mathematics (2 papers)	Final, Part II	June
Strength of Materials and Vibrations	,,	,,
Theory of Structures	,,	,,
Hydraulics	,,	,,
Surveying	,,	,,
Civil Engineering I	,,	,,
Civil Engineering II	,,	,,
Geology	,,	,,
Electrical Engineering Students :		
Mathematics (2 papers)	Final, Part II	June
Strength of Materials and Vibrations	,,	,,
Mechanisms and Thermodynamics (including Heat Transmission)	,,	,,
Electrical Theory, Measurements and Materials ...	,,	,,
Electrical Machines	,,	,,
Electrical Power	,,	,,
Electronics	,,	,,
Electrical Communications	,,	,,
Aeronautical and Mechanical Engineering Students :		
Mathematics (2 papers)	Final, Part II	June
Thermodynamics	,,	,,
Fluid Mechanics	,,	,,
Strength of Materials and Vibrations	,,	,,
Theory of Machines	,,	,,
Electrical Engineering	,,	,,
Mechanical Engineering I	,,	,,
Mechanical Engineering II	,,	,,
THIRD YEAR		
Chemical Engineering Students :		
Fuel Combustion and Furnaces	Final, Part II	January
Chemical Engineering I	,,	June
Chemical Engineering II	,,	,,
Chemical Engineering III	,,	,,
Chemical Engineering IV	,,	,,

DEPARTMENTAL SECTION

The following section gives information regarding the various departments arranged in the following order :—

Aeronautics.

Botany (including Plant Physiology, Plant Pathology, Bacteriology and Biochemistry).

Chemistry (including Inorganic and Physical, Organic, and Agricultural Chemistry, and the Chemistry of Food, Drugs and Water).

Engineering—

- Aeronautical.
- Chemical.
- Civil.
- Electrical.
- Mechanical.

Geology (including Mining Geology and Oil Technology).

Mathematics.

Metallurgy.

Meteorology.

Mining.

Physics (including Astrophysics, Technical Optics, and Applied Geophysics).

Zoology and Applied Entomology.

TIME-TABLE FOR PRELIMINARY (INTERMEDIATE) YEAR

First Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Physics Laboratory P.8.	Mathematics M.1.	Mathematics M.1.	Physics Laboratory P.8.	Mathematics M.1.
11–12.			Physics Class Work P.7.		
12–1.	Physics Lecture P.1, 3, 5	Physics Lecture P.2, 4, 6.	Physics Lecture P.1, 3, 5.	Physics Lecture P.2, 4, 6.	Physics Lecture P.1, 3, 5.
2–3.	Physics Revision	Mathematics M.1.	Mathematics (optional)	Physics Class Work P.7.	Physics Laboratory P.5.
3–4.	Mathematics M.1.	Physics or Astrophysics Laboratory P.8.		Physics or Astrophysics Laboratory P.8.	
4–5.					

Second Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Chemistry Laboratory C.047.	Mathematics M.2.	Mathematics M.2.	Mathematics M.2.	*Mathematics M.2.
11–12.			*Chemistry Laboratory C.047.	Chemistry Laboratory C.047.	
12–1.	Chemistry Lecture C.021.	Chemistry Lecture C.042.			Chemistry Lecture C.021.
2–3.	Chemistry Lecture C.041.	Chemistry Laboratory C.047.	†Mathematics M.2. (optional)	Chemistry Lecture C.021.	Chemistry Lecture C.021.
3–4.	Mathematics M.2.			Chemistry Laboratory C.047.	Chemistry Laboratory C.047.
4–5.					

* R.S.M. students take Practical Geometry (Min. 1A) in the R.S.M., 11–12 on Wednesdays and 10–12 on Fridays.

† All R.S.M. students, except Min. Geology, take Principles of Machines (Min. 1) from 2–5, in the R.S.M.

DEPARTMENT OF AERONAUTICS

The Department of Aeronautics provides courses of study in Aeronautical Science and Engineering, for students proceeding to the B.Sc. (Engineering) Degree, for students proceeding to the B.Sc. (Physics) Degree, for students qualified or qualifying in Mathematics or Physics and for Postgraduate students who have obtained suitable qualifications (either at the Imperial College, or elsewhere) in Engineering, Mathematics, or Physics. The courses are also available to part-time students, and, with the consent of their College, to students of other Colleges within the University of London.

Courses in Aerodynamics, Theory of Aircraft Structures, Aircraft Propulsion, and Aircraft Design are provided in the third undergraduate year, and in a postgraduate year. Internal students of the College may enter the department in their third undergraduate year, having spent their first two years at the College in a study of general engineering subjects, or of Physics.

For details of courses, conditions of entry, and description of the Department, see pages 93-99 *under Engineering (Aeronautical).*

DEPARTMENT OF BOTANY

Accommodation consists of four large and six smaller laboratories, and a number of rooms for staff and senior research workers. There are in addition a roof greenhouse, lecture room, museum, herbarium, departmental library, photographic room and workshop.

The research laboratories are fitted up mainly for work in Plant Physiology, Biochemistry, and in various aspects of Microbiology, viz., Mycology, Bacteriology and Plant Pathology. Special facilities are available for Plant Physiological research at the Rothamsted Experimental Station, and Plant Pathological investigations are carried out on a field scale at Slough and Harlington, at both of which there are field laboratories.

Associateship and Degree Course in Botany

Students entering the *Intermediate Year* for the A.R.C.S. and B.Sc. (Special) in Botany should normally have satisfied the minimum University Entrance requirement, and reached at least Ordinary level at the General Certificate of Education in Chemistry, Physics and Mathematics.

Students who seek to enter the *First Year* course of study must normally have reached the standard of the Intermediate Science Examination of the University of London in subjects including Chemistry and Physics, with Mathematics as a desirable addition, and will be expected to have a knowledge of the elements of organic chemistry ; a previous knowledge of Botany and/or Zoology with or without examination qualifications is not considered necessary although all intending students should have a keen interest in plants and in the natural or cultivated vegetation of the countryside.

The courses deal with the general morphology and anatomy of representatives of the main groups of the vegetable kingdom ; the ecology and taxonomy of flowering plants ; physiology of plants ; plant pathology ; biochemistry and genetics. Use is made of field facilities at Slough and Harlington for instruction in methods of experimentation with growing crops. During summer vacations students are encouraged, under the advice and guidance of the Professor, to gain wider experience by spending some period as an assistant at a research station or similar centre of advanced or applied work.

As the courses of Zoology and Botany students are identical until half way through the first half-session of the First Year a student may apply for transfer from one course to the other during this period.

Students of the department who hope to work in the tropics may attend, without charge, a course on Tropical Hygiene (*see* Min. 13).

Intermediate Year

The subjects of the *Intermediate Year's* work are :—

First half-Session :—

Physics :—P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Pure Mathematics :—M.1.

Second Half-Session :—

Chemistry :—C.021, C.041, C.042, C.047.
Applied Mathematics :—M.2.

First Year

The subjects of the *First Year's* work are :—

First Half-Session :—

Botany :—B.2, B.2a, B.3, B.3a.
Zoology :—Z.1, Z.2.

Second Half-Session :—

Geology :—G.1, G.2, G.3 *or* Chemistry :—C.115, C.123.
Botany :—B.4, B.5, B.5a, B.7, B.16.

Second Year

The subjects of the *Second Year's* work are :—

Botany :—B.5, B.6, B.7, B.12, B.13, B.17.

Third Year

The subjects of the *Third Year's* work are :—

Botany :—B.8, B.9, B.9a, B.10, B.11, B.14, B.15, B.18.
Entomology :—Z.26.

Syllabuses.

B.1. General Biology.

Mr. Howarth.

This course of 45 lectures is designed for students who will not normally proceed to advanced studies in Botany or Zoology —at present students in Chemistry and Geology.

Syllabus :—Cells, tissues, organs, organ systems and general morphology of the flowering plant and mammal, including man ; the functional activities of plants and animals, metabolism, growth, irritability, reproduction ; mitosis and meiosis ; embryology ; genetics with special reference to the breeding of higher plants and animals ; a brief study of lower plants and animals ; saprophytism, parasitism, symbiosis ; evolution. Stress is laid on the inter-dependence of plants and animals, their basic resemblances and differences ; on forms and factors of economic importance and on basic concepts of the causes and prevention of disease in plants and animals.

B.1a. Laboratory Work in Biology.

Mr. Levy and Mr. Goto.

Syllabus :—The histology, anatomy and morphology of the flowering plant and of the rabbit by the handling of selected materials, by section and/or dissection ; experiments illustrative of the principles of general physiology, reproductive structures and processes ; embryo development ; mitosis and meiosis. Selected types of Algae, Bryophytes, Ferns, Gymnosperms, Fungi and Bacteria, and of *Amœba*, *Paramœcium*, *Euglena*,

Hydra, *Obelia*, Earthworm, Cockroach, Tapeworm, Crayfish, Mussel, Starfish, Dogfish and Frog will be studied so as to illustrate the variety of plant and animal form and life-history and the ways in which basic biological requirements for individual existence and race continuance have been met at different levels.

B.2. General Botany.

Prof. Brown.

A course of about 25 lectures. *Syllabus* :—The cell ; mitosis and meiosis ; types of tissue and their development ; the anatomy and morphology of angiosperms (with special reference to features of economic importance) ; vegetative reproduction, natural and by cuttings and grafts ; plant physiology ; heredity and variation.

B.2a. Laboratory Work in General Botany.

Dr. Rutter and Miss Stedman.

Syllabus :—The histology, anatomy and morphology of the vegetative structure and reproduction of angiosperms by the examination of selected materials aided by the preparation of double-stained permanent preparations. Experiments illustrative of the principles of physiology will be carried out by students.

B.3. Plant Geography.

Dr. Pratt.

A course of about 20 lectures on the more important types of vegetation throughout the world, their physiognomy, constitution and distribution.

B.3a. Laboratory Work.

Dr. Pratt.

Syllabus :—Detailed studies of the histology, anatomy, morphology and biology of ecological types ; hydrophytes, xerophytes, lianes, epiphytes, insectivores, parasites, saprophytes, etc.

B.4. Economic Plants.

Dr. Pratt.

A course of 12 lectures, with suitable laboratory demonstrations, on plants of economic importance, their distribution, cultivation, preparation and uses.

B.5. Floral Morphology and Taxonomy of Angiosperms.

Dr. Pratt.

A course of 12 lectures on the structure and development of the flower and its parts ; of the seed and fruit and their dispersal ; the main lines of floral evolution and the principles of taxonomy. A study of selected families of British plants will be made and familiarity with the use of a flora inculcated.

As far as is practicable these lectures will be given at the Chelsea Physic Garden. This course will continue to an advanced stage (about 20 lectures with laboratory work) into Second Year.

B.5a. Laboratory Work on Taxonomy.

Dr. Pratt.

Practical work illustrative of the substance of lectures B.5. So far as is found practicable, this work will be carried out in the garden and laboratory of Chelsea Physic Garden.

B.6. Comparative Morphology, etc.

Mr. Howarth and Mr. Madelin.

Lectures with illustrative laboratory work on the nature and microchemical reactions and recognition of structural and storage materials in plants : wound reactions, galls, regeneration, cuttings, grafts, and a detailed morphological, anatomical and histological examination of representative members of Algae, Bryophytes, Vascular Cryptogams and Gymnosperms together with the more important fossil forms ; their life-histories, inter-relationships and evolution.

B.7. Field Work.

Field work is encouraged at all levels and day excursions are conducted by members of Staff responsible for the various courses. In addition, special excursions under the direction of Mr. Howarth, Dr. Pratt and Dr. Rutter are made in April and in June, immediately after the close of the session and usually for one week's duration to study the composition and distribution of the flora of a selected locality. Attendance on these excursions is compulsory for students who have just completed their first year's course and those who are attending or have completed their second year's course. Localities are selected so as to give as wide a range as possible of field experience but all students are expected to pursue field studies on their own initiative.

B.8. Mycology.

Dr. Wood and Miss Mount.

A course of about 36 lectures beginning in late October on the morphology and phylogeny of the fungi. The laboratory work includes a training in the technique of culture methods and an examination of leading representatives of the more important families and genera of fungi.

B.9. Plant Pathology.

Prof. Brown and Dr. Wood.

The lectures, numbering about 30, will deal with the physiology of fungi, more particularly with factors controlling growth and reproduction, fungal variation, fungal enzymes. Lectures in second half-session will deal with the general nature of disease in plants, the nature of immunity and resistance, specialisation of parasitism, life-histories of some of the more

important parasites, general review of systematic plant pathology, control measures.

B.9a. Laboratory and Field Work.

Prof. Brown and Dr. Wood.

The practical work in the first term will consist of an experimental study of the physiological aspects of fungal growth and parasitism. In the third term the practical course will be conducted at Harlington, and will be devoted to the study of disease under field conditions.

B.10. Plant Ecology.

Dr. Rutter.

A course of about 20 lectures beginning in January on plant succession and the structure of plant communities in relation to environmental factors ; plant competition and the modification by vegetation of its environment ; the application of ecological concepts to agriculture and forestry. Concurrent laboratory studies (daily 11–1 and 2–5) on some physical and chemical properties of the soil and the inter-relationship between soil and vegetation will be made. Field work to illustrate methods of vegetation analysis and measurement of environmental effects will be arranged.

B.11. Cytology and Genetics.

Mr. Howarth.

About 25 lectures on Cytology and Genetics beginning in the second half-session. Special emphasis is laid on the theory and practice of Plant Breeding. Four weeks of the second term are devoted to laboratory practice in the techniques of cytological preparations and their interpretation.

B.12. General Physiology.

Prof. Gregory.

The lectures, about 35 in number, will include a consideration of the physical and chemical relationships of protoplasm, the relationship of the plant to water, the absorption of water and of mineral constituents, transpiration, assimilation and respiration.

B.13. Laboratory Work in Physiology.

Dr. Heath and Dr. Spanner.

The practical work will include an experimental study both qualitative and quantitative of the chief physiological processes of the plant.

B.14. Physiology of Growth.

Prof. Gregory.

A course of lectures with practical work during the first and second terms dealing with morphogenic factors and the theory of manuring. Subjects dealt with include the effects of external factors, the inter-relations of nutritive and external factors, photoperiodism and vernalisation, the meaning and

use of growth curves in growth analysis, plant hormones and current theories of tropic responses and growth.

B.15. Statistical Methods.

Dr. Heath.

A course of about 10 lectures during the second term with practical exercises, dealing with the application of statistical methods to biological problems.

B.16. Elementary Organic Chemistry.

Dr. Buston and Dr. Russell.

A course of 12 lectures dealing with the chemistry of the simpler groups of organic compounds ; organic analysis, structure, synthesis.

Laboratory work :—Analysis of simple organic compounds ; organic preparations chosen to illustrate the more important principles of organic reactions and the commoner laboratory techniques.

B.16a. Chemistry of Natural Products.

Dr. Russell.

A course of 16 lectures on the chemistry of the principal constituents of living matter—sugars, polysaccharides and related compounds, fats and lipoids, proteins, natural pigments.

B.17. Biochemistry.

Dr. Buston.

A course of about 16 lectures dealing with biochemistry from a dynamic aspect. Enzymes and enzyme-action ; metabolism of carbohydrates ; fermentation and respiration ; development of the plant cell-wall ; metabolism of fats ; nitrogenous metabolism ; growth factors and hormones.

Laboratory work :—Practical courses in conjunction with B.16a and B.17 are designed as a whole, and comprise exercises on the preparation and analysis of the principal components of plants, simple exercises in enzyme techniques, and demonstrations of more advanced methods.

B.18. Plant Bacteriology.

Dr. Jacobs and Dr. Lacey.

About 15 lectures in October on bacteriology, followed by laboratory work, with special reference to the bacteriological diseases of plants.

B.19. Bacteriology of Soil, and of Foods and Drugs.

Dr. Jacobs and Dr. Lacey.

A course of 20 lectures, with laboratory work, beginning in November. The course will include a discussion of the morphology and physiology of bacteria ; a general introduction to bacteriological technique ; a consideration of the bacteriology and mycology of food ; water bacteriology and sewage disposal ; milk production ; disinfection ; the organisms of the soil and the various biological processes occurring therein. The experiments performed in the laboratory are arranged to suit the interests of the two groups of students.

B.20. Bacteriology for Public Health Engineers.

Dr. Jacobs and Dr. Lacey.

A course of 25 lectures and 50 hours, laboratory work, held twice weekly from December to the end of the Spring Term. The course covers the nature, characteristics and identification of bacteria ; laboratory techniques ; the role of bacteria in the transmission of disease ; the biochemical reactions of important bacteria ; the effects of physical, chemical and biological agents on bacteria ; disinfection ; the bacteriology of water, sewage, milk, food and the air.

B.21. Properties of Timber.

Mr. J. F. Levy.

A course of about 10 lectures and demonstrations on Timber, for Engineers and Architects, during the first and second terms. The course will deal with the structure, identification and physical properties of the timber commonly used for engineering purposes in Europe ; structural characters determining the qualities of these ; defects in timber, their identification and their effects on the various physical properties of wood ; decay, insect pests ; seasoning and preservation.

Courses in Botany for Zoologists

B.22. General Botany.

Prof. Brown.

A course of lectures as B.2 with in addition studies of flora morphology ; the development and structure of floral organs ; pollination, fertilisation, embryo development ; seed and fruit formation and dispersal ; germination ; trends of floral evolution and an outline of classification. Studies of the structure and life-history of selected types of Gymnosperms, Vascular Cryptogams, Bryophytes, Algae, Fungi and Bacteria, Lichens ; the relation between plant structure and environment.

B.22a. Laboratory Work.

Dr. Rutter and Miss Stedman.

As B.2a, together with an examination of types illustrative of the plant groups and processes dealt with in lectures B.22.

B.23. Ecological and General Botany.

Dr. Pratt.

A course of lectures and laboratory work throughout the first half-session dealing with plant geography, ecology and economic plants, with an introduction to the taxonomy of angiosperms and to the use of a flora in the study of British vegetation.

B.24. Plant Pathology.

Prof. Brown and Dr. Wood.

A course of 12 lectures with practical work during the second Term for students of Zoology and Agricultural Chemistry.

B.25. Plant Physiology.

Dr. Heath.

A course of 10 lectures with laboratory work during the third Term adapted to the needs of students of Zoology.

Advanced and Postgraduate Work

The department is well equipped for the investigation of problems in most of the important branches of botanical study ; special facilities are offered to advanced students for study and research in :—physiology of plants, with special reference to problems of plant growth and metabolism ; morphology and physiology of fungi ; physiology of parasitism ; investigation of diseases of plants caused by parasitic fungi ; general bacteriology ; bacteriological diseases of plants ; soil bacteriology ; biochemistry. There is accommodation for postgraduate students wishing to take the M.Sc. Degree (by examination) in Microbiology. There is a greenhouse attached to the South Kensington laboratories and there are facilities for raising plants and some accommodation for research workers by arrangement with the authorities of the Chelsea Physic Garden. Research work on a field scale is carried out at Slough and Harlington, at each of which there are field laboratories.

Research Institute of Plant Physiology

The department includes as an integral part the Research Institute of Plant Physiology, which receives grants from the Ministry of Agriculture for the investigation of problems of plant physiology of importance in agriculture and horticulture. By arrangement with the Rothamsted Experimental Station and East Malling Research Station, facilities for pot-culture and field work in plant physiology are available at these stations.

BOTANY

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—1st Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Zoology Lecture Z.1.	Botany Lecture B.2 and 3.	Zoology Lecture Z.1.	Botany Lecture B.2 and 3.	Zoology Lecture Z.1.
11–12.	Zoology Laboratory Z.2.	Botany Laboratory B.2a and 3a.	Zoology Laboratory Z.2.	Botany Laboratory B.2a and 3a.	Zoology Laboratory Z.2.
12–1.					
2–3.	Zoology Laboratory Z.2.	Botany Laboratory B.2a and 3a.	Zoology Laboratory Z.2.	Botany Laboratory B.2a and 3a.	Botany Lecture B.2 and 3.
3–4.					
4–5.					Botany Laboratory B.2a and 3a.

BOTANY
FIRST YEAR—2nd Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	Geology Laboratory G.2.	Botany Laboratory	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.
12–1.				Palæontology Lecture G.1.	
2–3.	Botany Lecture B.3, 4 and 5.	Organic Chemistry Lecture B.16.	Botany Lecture B.3, 4 and 5.	Palæontology Laboratory G.2.	Organic Chemistry Lecture B.16.
3–4.	Botany Laboratory B.3a and 5a.	Organic Chemistry Laboratory B.16.	Botany Laboratory B.3a and 5a.		Organic Chemistry Laboratory B.16.
4–5.					

Students taking Ancillary Chemistry follow Chemistry Lectures and Laboratory work in place of Geology above.

BOTANY
SECOND YEAR—First Two Terms
(During two weeks of the course laboratory instruction is given in Biochemistry.)

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Botany B.6.	Botany B.6.	Botany B.6. *B.5a.	Botany B.6.	Botany B.5. *B.6.
11–12.					
12–1.		B.5.			
2–3.	Botany B.5. *B.6.	Biochemistry B.17. *B.5.	Botany B.6.	Biochemistry B.17. *B.5.	Botany B.6.
3–4.	B.5a. *B.6.	Botany *B.5a.	Botany B.6.	Botany B.6. *B.5a.	
4–5.					

BOTANY
SECOND YEAR—Third Term

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–1.	Botany B.12 and 13.	Botany B.12 and 13.	Botany B.12 and 13.	Botany B.12 and 13.	Botany B.12 and 13.
2–5.	B.13.	B.13.	B.13.	B.13.	B.13.

* From end of First Half-Session.

DEPARTMENT OF CHEMISTRY

The Chemistry Departments occupy the eastern half of the Royal College of Science building, on the south side of Imperial Institute Road.

New laboratories provided by reconstruction of the old *Main Analytical Laboratory* are now in use. These comprise an analytical laboratory for first year chemistry students, and the *Philip*, *Crookes*, and *Edward Frankland Laboratories*, providing for recently-introduced advanced courses in physical, inorganic, and organic chemistry, respectively, and including accommodation for students from other departments.

The *Advanced Analytical Laboratory* for inorganic chemistry has 44 working places ; balance rooms, service rooms, and a special room for use of hydrogen sulphide are attached.

Two *Physical Chemistry Laboratories*, with an optical laboratory and darkroom attached, are provided ; one of these is devoted principally to electrochemistry.

The *Hofmann Laboratory* for organic chemistry, recently rebuilt, accommodates about 60 students, and has subsidiary rooms for stores, etc.

The *Whiffen*, *Perkin*, and *Armstrong Laboratories* are devoted to research in organic chemistry. The organic chemistry research laboratories also include rooms devoted to spectrography, micro-analysis, and high-pressure reactions. The principal inorganic chemistry research laboratory has an annexe accommodating X-ray crystallographic equipment. A number of other *Research Laboratories* and private rooms for members of staff are provided in both Departments.

Special accommodation is also available for students of agricultural chemistry and of the analytical chemistry of food and drugs. In addition, field station facilities (comprising experimental plots and laboratory accommodation) are available for agricultural chemistry students at Harlington and elsewhere. Other laboratories are equipped for courses in microchemistry and in physical methods of analysis.

Lecture Rooms.—(1) The principal chemistry lecture theatre provides seating accommodation for 164 students, and can accommodate a larger audience on special occasions. Immediately behind the theatre are several rooms for the storage of apparatus, for the preparation of demonstrations, and for the use of the lecture assistant.

(2) The physical chemistry lecture theatre accommodates about 70 students.

(3) The organic chemistry lecture theatre accommodates about 80 students.

(4) A small lecture theatre in the reconstructed section of the buildings has limited accommodation for postgraduate lectures and colloquia.

Library.—The Chemistry Library contains a number of the more important British and foreign chemical journals, dictionaries, and works of reference, as well as certain modern text books. Some of

the books of reference relating more especially to the practical work of the various sub-departments are housed in those sub-departments.

Courses of Study

Students intending to take Chemistry as their Special Degree subject are not admitted to pre-Intermediate courses. Students who seek to enter the first year course of study must normally have reached the standard of the Intermediate Science Examination of the University of London in Chemistry, Physics and Mathematics. All candidates, unless in exceptional cases there is other evidence that their attainment in Chemistry is such as to afford a reasonable prospect of success in the first year work, are required to pass a special Chemistry test (theory and practical). This test, while based upon the usual syllabus for the Intermediate or General Certificate Examination, is intended to provide a more searching test of the candidate's understanding of fundamental facts and principles. Exemption from any part of the first year course is granted only in exceptional circumstances, but the normal courses of laboratory instruction may be varied to meet the needs of students who have had special experience in the laboratory.

Students admitted to the Department now take a new undergraduate course, covering three sessions after attainment of Intermediate standard. The first year of this course is spent mainly on lectures in the three principal branches of chemistry, and on practical work in inorganic analysis and elementary physical chemistry ; a proportion of the time, however, is devoted to special courses (involving lectures, tutorial classes, and practical work) in physics and mathematics, these courses being designed adequately to equip the student for later work in theoretical physical chemistry. The second post-Intermediate year is devoted entirely to chemistry. During the first half-session, lectures are given in physical and inorganic chemistry, practical work being carried out in advanced inorganic analysis and more advanced physical chemistry. During the second half-session, lectures are devoted to organic chemistry, and all the time available for practical work is spent in the organic chemistry laboratories.

The main part of the Degree examination comprises written papers in (i) general and physical chemistry, (ii) physical chemistry, (iii) inorganic chemistry, and (iv) organic chemistry (two papers), together with two-day practical examinations in both inorganic and organic chemistry.

The third year of the new course comprises more advanced study, by both lectures and practical work, of either (i) physical and inorganic chemistry or (ii) organic chemistry, together with a course in some accessory subject selected by the student, such as biology, mineralogy, or any other course which may at the time be available for this purpose. An assessment of the student's work during this year is made, and the class of Associateship and Degree awarded is determined at the end of this year.

Since the final examination includes translation of passages in German, some knowledge of the language at entry is desirable ;

instruction in German is, however, given during part of the course.

Students seeking to undertake research work or to attend post-graduate courses of study in the Department must normally have passed the B.Sc. (Special) Examination in Chemistry, or some equivalent Examination.

The M.Sc. Degree is taken as a rule by research, but in certain branches of Chemistry it may be taken by Examination. The Ph.D. and D.Sc. Degrees are awarded only for research.

The diploma of F.R.I.C. (Fellowship of the Royal Institute of Chemistry) may be taken in Inorganic Chemistry : Physical Chemistry : Organic Chemistry ; Biochemistry ; the Chemistry (including Microscopy) of Food, Drugs and Water ; Agricultural Chemistry : and Industrial Chemistry. The appropriate regulations, together with the regulations governing the award, with or without examination, of the Associateship of the Royal Institute of Chemistry, may be obtained from the Registrar, Royal Institute of Chemistry, 30, Russell Square, London, W.C.1.

Notes respecting Chemical Laboratories.

The laboratories are normally open from 10 a.m. to 1 p.m. and from 2 p.m. to 5 p.m. on each week day except Saturday. Undergraduates are not permitted to work in the laboratories at any other times unless they have previously received special permission. No student may perform experimental work involving risk of accident, unless some other person is within call.

Apparatus is provided. Text books—other than certain laboratory pamphlets—are not provided, but students have access to the Departmental Library.

In order that normal facilities may be maintained as fully as possible, it is necessary that students should co-operate by exercising proper economy in the use of supplies and services.

ASSOCIATESHIP AND DEGREE COURSE IN CHEMISTRY

First Year

Chemistry :—C.111, C.117, C.121, C.131, C.137, and C.147.
Physics :—P.9.
Mathematics :—M.5.
German :—C.101.

Second Year

First Half-Session :—

Chemistry :—C.211, C.217, C.221, and C.247.

Second Half-Session :—

Chemistry :—C.231 and C.237.

Third Year

Chemistry :—C.311, C.317 and C.347.
or
C.331 and C.337.
Accessory subject :—See p. 71.

Syllabuses*

First Year

C.101. German.

Dr. Carlton and Others.

Courses are given in elementary German grammar and reading, with special reference to chemical terms and translation from German chemical literature.

C.111. Physical Chemistry Lectures.

Dr. Tompkins and Dr. Kitchener.

A course of about 44 lectures.

Syllabus :—*Thermodynamics.*—(about 25 lectures by Dr. Kitchener). The First and Second Laws of thermodynamics. The thermodynamic functions *U*, *H*, *S*, *A*, *G*, and some applications. Partial molar quantities ; chemical potential ; fugacity and activity. Treatment of chemical equilibria ; the Third Law. Treatment of ideal solutions from the thermodynamic viewpoint ; laws of dilute solutions.

Phase Equilibria (about 8 lectures by Dr. Kitchener). Condensed treatment of systems of one, two, and three components.

Kinetic and Molecular Theory of Gases, Liquids, and Solids (about 11 lectures by Dr. Tompkins). Elementary statistical treatment of the kinetic theory of ideal gases and discussion of the Maxwell-Boltzmann distribution law ; real gases, critical phenomena. The structure and properties of liquids and solids. An introduction to quantum theory.

C.117. Physical Chemistry Laboratory.

Dr. Tompkins, Dr. Kitchener, Dr. Bockris, and Dr. Cullis.

Groups of students spend four weeks receiving instruction in practical physical chemistry. The course includes the physicochemical properties of gases, liquids, and solids, and the properties of simple binary systems.

C.121. Inorganic Chemistry Lectures.

Dr. Welch and Dr. Roberts.

A course of about 36 lectures.

Syllabus :—*Radioactivity* (about 6 lectures by Dr. Roberts). The elementary particles of matter. Natural radioactivity.

Atomic and Molecular Structure : *Structure of Solids* (about 18 lectures by Dr. Welch). Atomic structure and the Periodic Classification. Valency. Methods of determining the structure of molecules. Complexes ; isomerism in inorganic molecules. Bond types and structure types in solids. Non-stoicheiometric and interstitial compounds.

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* In the course numbers in this section, the *first* figure indicates the post-Intermediate year to which the course belongs, the figure 0 denoting an Intermediate course. The *second* figure represents the broad subject of the course (1, physical chemistry; 2, inorganic chemistry; 3, organic chemistry; 4, analytical chemistry; 5, chemistry of food, drugs, and water supplies; 6, agricultural chemistry). The *third* figure distinguishes individual courses, lecture courses being numbered 1 to 6 and laboratory courses 7 to 9.

Extraction of Metals (about 4 lectures by Dr. Roberts). A general survey of the chemistry of processes used in the extraction of metals.

General Inorganic Chemistry (about 8 lectures by Dr. Welch). The systematic chemistry of the less common elements. (Course C.221 is a direct continuation of this part of the course.)

C.131. Organic Chemistry Lectures.

A course of about 54 lectures on general organic chemistry.

Syllabus :—The classification, nomenclature, structure, and isomerism of organic compounds. Elementary consideration of the application of electronic concepts of valency in connection with physical properties, structural problems, reactivity, and reaction mechanisms. The above are illustrated by reference to the preparation, properties, and characteristic reactions of the major classes of aliphatic and benzenoid compounds. Emphasis is laid upon the production and utilisation of substances of industrial importance.

C.147. Inorganic Chemistry Laboratory.

Mr. Theobald, Dr. Welch, Mr. Bull, Dr. Roberts, Dr. Carlton, Dr. Herringshaw, Dr. David, and Dr. Hills.

A course of experimental work.

Syllabus :—Calibration of weights and volumetric apparatus. Volumetric analysis. Gas analysis. Simple gravimetric analysis. Qualitative inorganic analysis.

C.137. Organic Chemistry Laboratory.

Dr. Crombie.

A short course on simple organic chemical preparations and reactions.

Second Year

C.211. Physical Chemistry Lectures.

Dr. Tompkins, Dr. Kitchener, Dr. Bockris, and Dr. Cullis.

A course of about 60 lectures on advanced physical chemistry.

Syllabus :—*Statistical Mechanics.* (8 lectures by Dr. Tompkins.) Statistical treatment of entropy and the expression of thermodynamic functions in terms of partition functions.

Quantum Theory (about 15 lectures by Dr. Tompkins). Fundamental postulates ; the Schrödinger wave equation ; the harmonic vibrator and fixed-axis rotator ; the hydrogen atom ; atomic spectra ; quantised translational motion ; translational partition function ; valency and intermolecular forces. Molecular spectra of simple molecules ; predissociation and Raman spectra ; spectroscopic energy of dissociation, and evaluation of partition functions.

Kinetics and Mechanism of Gaseous Reactions (14 lectures by Dr. Cullis). Classification of chemical reactions ; general principles of chemical kinetics, order of reaction, molecularity, Arrhenius law, activation energy ; experimental methods, some typical bimolecular, unimolecular and termolecular gas reactions ; chain reactions,

evidence for free radicals, branching and non-branching chains; photochemical reactions, Einstein's law, quantum efficiency, some typical photochemical reactions. Heterogeneous gas reactions, kinetics of heterogeneous processes, mode of action of heterogeneous catalysts.

Electrochemistry (15 lectures by Dr. Bockris). General theory of gaseous and liquid polar dielectrics. Statistical treatment of interionic forces; transition-state theory of conduction and ion diffusion. Relaxation and electrophoretic phenomena, Debye and Wien effects. Theory of proton-transfer processes; ion-pair formation; Fuoss-Krauss theory. Ionic melts. Statistical treatment of ion-solvent forces; solvation number; electrostatic theory of salting-out. Non-aqueous solutions. Theories of E.M.F. and electrode-solution potential difference; statistical distribution of potential at electrolyte-metal interface; capacity of double layer. Thermodynamics of cells, activity coefficients, free energy and entropy of ions; redox reactions. Overpotential; quantum theory of proton discharge. Cathode-ray oscillography and other electronic techniques.

Surface Chemistry (8 lectures by Dr. Kitchener). Adsorption of gases on solids and of solutes from solution. Surface films. Electrical phenomena at surfaces; electro-capillarity and electrokinetic effects. The elementary principles of colloid chemistry.

C.217. Physical Chemistry Laboratory.

Dr. Tompkins, Dr. Kitchener, Dr. Bockris, and Dr. Cullis.

The first year course in practical physical chemistry (C.117) is continued and amplified during a further period of four weeks during the first half-session of the second year. The practical work includes experiments in electrochemistry and chemical kinetics.

C.221. General and Inorganic Chemistry Lectures.

Prof. Briscoe, Dr. Welch, and Dr. Roberts.

This course is a direct continuation of course C.121.

Syllabus :—(*a*) (16 lectures by Prof. Briscoe and Dr. Welch). The systematic chemistry of the less common elements. The determination of atomic weights by chemical methods.

(*b*) (8 lectures by Dr. Roberts). Artificial radioactivity and nuclear structure. Separation of isotopes. Use of isotopes as tracers.

C.231. Organic Chemistry Lectures.

Prof. Linstead, Dr. Owen, Dr. Braude, Dr. Weedon, and Dr. Elvidge.

Courses on more advanced organic chemistry.

Syllabus :—*Advanced General Lectures.*—Stereochemistry; alicyclic compounds; ring formation and ring stability; heterocyclic compounds; aspects of organic chemical industries.

Structure and Reactions of Natural Products.—Intermediate metabolites; carbohydrates; fats; amino-acids and proteins; an introduction to more advanced groups such as steroids, alkaloids, terpenes and carotenoids.

Theoretical Organic Chemistry.—Application of physical methods to the determination of the structure of organic compounds ; modern views of structure ; electronic theory of reactions ; methods of determining reaction mechanisms ; free radicals ; molecular rearrangements ; tautomerism ; polymerisation.

C.237. Organic Chemistry Laboratory.

Dr. Owen, Dr. Braude, Dr. Weedon, and Dr. Timmons.

Syllabus :—Preparation and purification of organic compounds. Studies of their properties and reactions, particularly by qualitative examination, including investigations of simple and complex mixtures.

C.247. Inorganic Chemistry Laboratory.

Mr. Theobald, Dr. Welch, Dr. Herringshaw, Dr. David, and Dr. Hills.

Syllabus :—Advanced inorganic chemical analysis : gravimetric and qualitative analysis, including the quantitative analysis of minerals ; the reactions of the less common elements on a semi-micro scale ; the analysis of mixtures and substances containing some of these elements ; and the identification of inorganic substances of varied types.

THIRD YEAR

Inorganic and Physical Chemistry.

C.311. Advanced Lectures in Inorganic and Physical Chemistry.

Professor Briscoe, Dr. Tompkins, Dr. Welch, Dr. Kitchener, Dr. Roberts, Dr. Bockris, Dr. Cullis, Dr. David, Dr. Hills, Mr. Dalziel and Dr. Jacobs.

This course is designed for students specialising in inorganic and physical chemistry. It will continue and amplify some aspects of the first and second year courses and provide opportunities for those students who wish to study specialised branches in greater detail.

The syllabuses of the theoretical courses will include :—

Nucleonics. Advanced radioactivity and radiochemistry.

Quantum mechanics ; quantum theory of valency ; electronic configuration of diatomic molecules ; molecular orbitals. Molecular structures of special interest (e.g., boron hydrides and carbonyls).

The solid state. Space-group theory and X-ray structure analysis. Order-disorder phenomena and non-stoicheiometry. Electronic processes in ionic crystals. Theory of the metallic state and of intermetallic compounds.

Advanced chemical kinetics ; transition-state theory ; polymerisation reactions ; phase transitions.

Advanced electrochemistry. Electrochemistry and inorganic chemistry of non-aqueous solutions. Electrode processes.

Dielectric and polarisation phenomena ; chemistry of materials with special electrical and magnetic properties.

Surface phenomena and colloid science.

A number of short courses covering selected topics in descriptive inorganic chemistry (e.g., fluorine and its compounds, the platinum metals, and the transuranic elements) will also be offered.

C.317. Advanced Inorganic and Physical Chemistry Laboratory.

Dr. Atkinson.

The course is designed to provide training in the use of modern instruments and in the techniques of inorganic and physical chemistry. Each experiment will be a research exercise involving the preparation and analysis of materials, the construction and calibration of apparatus, and the computation and evaluation of results. Such exercises will be selected from the following :

The kinetics of a gaseous, thermal or photochemical reaction, or of a solid-state reaction.

The adsorption of gases by a solid system. Study of a catalytic gaseous reaction.

Precision calorimetry.

Electrochemical studies involving the use of modern electronic equipment and the measurement of dielectric constants of liquids or solids.

X-Ray analysis and interpretation of typical X-ray patterns. Use of X-rays in phase equilibrium studies.

High-temperature techniques and study of chemical equilibria at high temperatures.

Quantitative absorption spectroscopy in the visible and ultra-violet regions.

The physico-chemical properties of high-polymer solutions.

The use of radioactive isotopes in physico-chemical problems.

Electrokinetic phenomena.

Photomicrography.

(Students taking this course will in many cases be advised to take selected parts of course C.347 as well.)

Inorganic and Physical Chemistry Dissertation.

Each student taking courses C.311 and C.317 will be required to write an original dissertation on a topic assigned to him. This will necessitate a critical study of the relevant literature but will not involve experimental work.

C.347. Advanced Analytical Chemistry.

Mr. Theobald and Dr. Herringshaw.

A continuation of course C.247, giving special emphasis to modern analytical techniques and to the analytical chemistry of certain rarer elements. Training will be given in physical methods of analysis (e.g., calorimetry, spectrophotometry, polarography, and spectrographic analysis) and in the elementary techniques of

semi-micro- and micro-analysis. Provision will be made for the special needs of individual students : if desired, the course can be made introductory to course C.447 and C.448.

Organic Chemistry

C.331. Advanced Lectures in Organic Chemistry.

Professor Linstead, Dr. Owen, Dr. Braude, Dr. Weedon, Dr. Elvidge, Dr. Hamer, Dr. Crombie, and Dr. Timmons.

This course is designed for specialists in organic chemistry and those desiring to study special aspects of the subject. It will continue and enlarge the material of the 2nd Year Post-Intermediate Course.

Syllabus :—New reactions of value in synthesis and degradation : new techniques of organic chemistry.

Advanced aromatic chemistry ; oxidation-reduction processes.

Aspects of organic chemical industries, including dyestuffs, plastics and synthetic fibres.

Special groups of natural products, including terpenes and carotenoids ; steroids, purines ; pyrimidines ; pyrroles ; porphyrins and nucleic acids.

Chemotherapy.

C.337. Advanced Organic Chemistry Laboratory.

Dr. Elvidge.

The course will consist of three parts, which will be blended to meet the needs of the individual student.

(i) Advanced training in modern technique of organic chemistry, to be selected from the following :—

Purification and Separation : fractional distillation, chromatography ; paper chromatography.

Analytical Procedures : micro- and semi-micro-techniques ; saponification and acetyl values ; Zeisel, Zerewitinoff, Van Slyke methods ; potentiometric titrations ; colorimetry.

Measurements : Rast molecular weight ; measurement of ultra-violet absorption spectra ; polarography.

Reaction Techniques : catalytic hydrogenation ; high pressure reactions ; high temperature catalytic reactions ; electrolytic preparations ; use of lithium alkyls and other special reagents.

(ii) Advanced preparations, particularly on a large laboratory scale and on a milligram scale.

(iii) An elementary research exercise.

Organic Chemistry Dissertation.

Each student will be required during the third year to write an original dissertation on a theme which will be assigned to him at the beginning of the year. The dissertation will call for a study and a critical summary of the relevant literature, but not for experimental work.

C.301. Course in English for Students of Science.

A course of lectures and tutorial work has been arranged in the Department of English at Birkbeck College under Professor Geoffrey Tillotson. It will be attended by Third Year students of the Chemistry Department. The primary object of the course will be to instruct students in the use of English so that they can express themselves in clear, logical and precise terms.

SPECIAL COURSES FOR STUDENTS FROM OTHER DEPARTMENTS

Intermediate Courses

C.021. General and Inorganic Chemistry Lectures.

Dr. Roberts and Dr. Carlton.

A course of about 60 lectures on systematic inorganic chemistry, with special reference to its technical applications.

Syllabus :—Properties of matter ; physical and chemical changes ; elements, mixtures, and compounds ; laws of combination ; the atmosphere ; oxygen ; catalysis ; oxides, acids, bases, salts ; hydrogen ; combustion, flame, and explosion ; water ; solutions ; liquefaction of gases. Atomic theory ; classification of the elements. The non-metals and their chief compounds ; the metals, their isolation and more important compounds and alloys.

C.041. Theory of Analysis Lectures.

Dr. Atkinson.

A course of about 8 lectures.

Syllabus :—Theory of ionic dissociation ; equilibria in reversible reactions ; strong and weak electrolytes ; buffer solutions ; hydrolysis ; precipitation ; theory of indicators ; amphoteric compounds ; complex compounds ; reactions and techniques used in qualitative analysis.

C.042. Chemical Theory and Calculations.

Dr. Roberts.

A course of about 12 lectures on chemical theory and calculations.

Syllabus :—Fundamental laws of chemistry. Avogadro's hypothesis. Determination of atomic and molecular weights. Thermochemistry. Theory underlying the experiments in volumetric and gravimetric analysis. Other theoretical topics of current interest.

Examples are worked in class, and problems to be solved by the student are set each week.

C.047. Chemistry Laboratory.

Dr. Carlton and Demonstrators.

A course of experimental work.

Syllabus :—Determination of equivalents ; simple gravimetric and volumetric analysis ; inorganic qualitative analysis.

COURSES FOR FIRST YEAR STUDENTS OF CHEMICAL ENGINEERING

C.112. Physical Chemistry Lectures.

A course of about 90 lectures.

First Half Session :—

Dr. Cullis and Dr. Jacobs.

Thermodynamics (32 lectures by Dr. Jacobs).

Definitions ; partial differentiation ; temperature ; heat, work and energy ; the first law ; heat capacity ; thermochemistry. Second law of thermodynamics, reversible processes, Kelvin temperature scale ; the entropy function and its applications ; calculation of standard entropies ; the third law of thermodynamics. Thermodynamic potential ; criteria of equilibrium. Phase equilibria in one component systems, the Clausius-Clapeyron equation ; the phase rule. Real gases, fugacity and activity. Chemical equilibria ; affinity of chemical processes ; reaction isotherm and isochore ; determination of standard free energies. Ideal and non-ideal solutions ; properties of dilute solutions ; activities ; partial molar properties.

Kinetic Theory of Matter (10 lectures by Dr. Cullis).

Ideal gas laws and their interpretation on basis of kinetic theory of gases. Calculation of molecular velocities. Maxwell's Distribution Law. Collision frequency ; mean free path and its relation to viscosity. Specific heats of gases. Deviations of real gases from ideal gas laws ; Van der Waals' equation of state. Critical Constants. Law of corresponding states.

Surface tension and viscosity of liquids. Applications to determination of constitution of liquids. Present views of structure of liquids.

Kinetics and mechanism of gaseous reactions (10 lectures by Dr. Cullis).

General principles of experimental technique. Influence of concentration on reaction rate ; order of reaction ; distinction from molecularity. Arrhenius equation ; concept of activation energy.

Homogeneous reactions. Some typical unimolecular, bimolecular and termolecular gas reactions. Chain and non-chain processes. Evidence for free radicals. Branching chains. Photochemical reactions. Einstein's law ; quantum efficiency.

Heterogeneous reactions. Adsorption of gases on solids ; Langmuir adsorption isotherm. Kinetics of heterogeneous processes. Mode of action of heterogeneous catalysts.

Second Half Session.

Dr. Kitchener, Dr. Herringshaw and Dr. Atkinson.

Phase Equilibria (12 lectures by Dr. Atkinson).

Classification of systems according to the Phase Rule. Treatment of one component systems ; polymorphism.

Pressure-composition and temperature-composition diagrams for mixtures of two liquids, including examples of partial miscibility ; fractional distillation and steam distillation. The

solid-liquid equilibrium in two component systems ; compound formation and solid solutions ; the iron-carbon system ; hydrate formation.

Representation of three component systems by triangular diagrams and solid figures, illustrated by melting point diagrams ; immiscibility diagrams, and salt-water systems.

Electrochemistry (12 lectures by Dr. Herringshaw).

Mechanism of electrolysis. Transport numbers. Electrolytic conductance. Ostwald's dilution law. Introduction to Debye-Hückel-Onsager theory. Reversible electrode potentials. Applications of electrode potential measurements. Concentration polarisation ; decomposition voltage ; overpotential. Anodic passivity ; the electro-deposition of metals ; electrolytic oxidation and reduction ; the corrosion of metals in liquids.

Surface Chemistry (8 lectures by Dr. Atkinson).

Principles of surface chemistry. Surface free energy, adsorption phenomena, surface activity, surface films, electrical double layers, electro-kinetic effects.

Applications of surface chemistry to gas adsorption, chromatography, detergency, emulsions, wetting, boundary lubrication, froth flotation of minerals. Lyophilic and lyophobic colloids and their rheological properties.

C.118. Physical Chemistry Laboratory.

Dr. Tompkins, Dr. Kitchener, Dr. Bockris, and Dr. Cullis.

A course in practical physical chemistry, similar in content to courses C.117 and C.217, held during the spring and summer terms.

C.122. Inorganic Chemistry Lectures.

A course of about 26 lectures by Dr. David.

The Periodic Table ; Bohr's theory of the atom. Valency. Elements of classical crystallography. Application of X-rays to the study of solids. Structures of metals and alloys. Production of fuel gases. Metallurgy of copper, zinc, magnesium and aluminium. The inorganic chemistry of less familiar elements, particularly lithium, beryllium, titanium, zirconium, vanadium, molybdenum, and tungsten.

C.132. Organic Chemistry Lectures.

Dr. Owen.

A course of about 54 lectures.

Syllabus :—Organic analysis ; general preparative methods ; introduction to theoretical organic chemistry ; systematic description of the preparation, properties, and reactions of the principal groups of aliphatic, aromatic, and the commoner heterocyclic compounds. The chemistry of petroleum, coal-tar derivatives, plastics, artificial fibres, medicinals, dyestuffs, and miscellaneous compounds of industrial value.

C.148. Inorganic Chemistry Laboratory.
Dr. Jacobs.

A course in elementary preparative and analytical chemistry held during the autumn term.

C.138. Organic Chemistry Laboratory.
Dr. Crombie.

A short experimental course illustrating important organic reactions and procedures.

MISCELLANEOUS UNDERGRADUATE COURSES

C.113. Physical Chemistry Lectures. (*Special lectures for Metallurgy and Mining students.*)
Dr. Welch, Dr. Atkinson, Dr. David, Mr. Dalziel and Dr. Burkin (Mining Dept.).

A course of about 65 lectures, having special reference to metals and processes of metallurgical interest.

Syllabus :—Atomic structure and radioactivity. Valency and the structure of simple molecules. The structure of solids, particularly metals and alloys. The Phase Rule : phase diagrams for binary and ternary systems. Chemical thermodynamics. Elements of electrochemistry. Surface chemistry and colloids.

Certain topics in inorganic chemistry, relating particularly to the less common elements, will be introduced into this course in order to illustrate physico-chemical principles.

C.114. Physical Chemistry Lectures. (*Special lectures for students of Geology, Mining Geology and Oil Technology.*)
Dr. Atkinson and Dr. Burkin (Mining Dept.).

A course of about 26 lectures.

Syllabus :—The physico-chemical properties of gases, liquids, and solids. Change of state. Phase equilibria in systems of one, two, and three components. Thermochemistry and chemical equilibria. The properties of electrolyte solutions. Surface chemistry and colloids.

C.115. Physical Chemistry Lectures. (*Special lectures for students of Botany and Zoology proceeding to Biochemistry.*)
Dr. Hills.

A course of about 30 lectures.

Syllabus :—Kinetic theory of gases. Change of state. Properties of liquids. Thermochemistry and simple thermodynamics-Colligative properties of solutions. Chemical equilibria. Reaction kinetics. Electrochemistry.

C.123. Inorganic Chemistry Lectures. (*Special lectures for students of Botany and Zoology proceeding to Biochemistry.*)
Dr. David.

A course of about 15 lectures on fundamental inorganic chemistry.

Syllabus :—Fundamental laws of chemistry. Classification of the elements. Fundamental particles and introduction to atomic structure. Natural and artificial radioactivity. Isotopes.

Separation of isotopes. Use of isotopes in biology. Classical and modern theories of valency. Introduction to the chemistry of solids.

C.361. Soil and Fertiliser Chemistry. (*Special course for Botany and Zoology students. In Suspense.*)

Mr. Pollard and Mr. Hannen.

Lectures.—A course of 10–12 lectures on the elementary chemistry and physics of soils and fertilisers ; practical use of fertilisers for different crops, soil types, etc.

Laboratory Work.—Each lecture is followed by laboratory work including simpler methods of soil examination and testing for fertiliser requirement.

Field Work.—Demonstrations are arranged at the Field Station of the effects of manurial treatment and other cultural practices on the growth, yield, and quality of crops.

RESEARCH.

C.411, 421. Research in Physical or Inorganic Chemistry.

Accommodation is available in about twenty laboratories. Special facilities are provided for research in mass spectrometry, X-ray diffraction, ultra-violet spectroscopy, the study of chemical and electrochemical equilibria at high temperatures, the use of isotopic tracers, and the application of various high-vacuum techniques. Adequate provision is also made for workshop and glass-blowing services. Special laboratories, recently re-equipped, are available for micro-chemistry and for the application of physical methods of analysis, including polarography and quantitative spectrographic analysis.

Postgraduate students are encouraged to attend the advanced course, C.311, which is supplemented by additional lectures on topics of current interest. In addition, research colloquia are held every two or three weeks. Course C.311 is likely to be of particular interest to postgraduate students who have not taken the third-year Degree course in physical and inorganic chemistry.

Current research is concerned with most of the main branches of physical and inorganic chemistry. The following list of fields of investigation is typical, but not exhaustive :—

(i) Kinetics of reactions in gaseous systems, including pyrolysis and oxidation processes, and in liquids.

(ii) Electrochemistry, with particular reference to hydrogen and oxygen overvoltage and special electrode processes, solvation of ions, and dielectric polarisation.

(iii) The preparation and X-ray crystallography of non-stoicheiometric oxide phases, and of simpler solid compounds of the platinum metals and other rare elements.

(iv) The preparation and structural investigation of solids having special magnetic and dielectric properties.

(v) Investigation of structures of mixed oxides of transition metals.

(vi) Adsorption and diffusion phenomena of gases and vapours on and in ionic crystals.
(vii) Biophysical chemistry of proteins and enzymes, studied by isotopic tracer techniques.
(viii) Physical chemistry (particularly the thermodynamics) of reactions in liquid iron.
(ix) Viscosity and electrical conductivity of molten silicates.
(x) Ion-exchange equilibria and chromatography.
(xi) Solid reactions and electronic processes in ionic crystals.
(xii) Certain specialised aspects of colloid chemistry.

Postgraduate students normally begin each session's work early in September and finish at the end of July. Applications for admission must reach the Registrar not later than May 1st, preferably earlier.

C.431. Research in Organic Chemistry.

Research in organic chemistry has been carried out at the College continuously since its foundation in 1845. Past Professors include Hofmann, Edward Frankland, H. E. Armstrong, Tilden, Jocelyn Thorpe and Heilbron. Seventeen rooms are available, of which the largest are the Whiffen, Perkin and Armstrong laboratories. They include special facilities for spectographic, high pressure and kinetic work, and two micro-analytical laboratories. Rooms for studies with radioactive trace elements are under construction.

Research students in organic chemistry may attend the advanced course in organic chemistry, C.331, and this may be supplemented by additional lectures on topics of current interest. Research colloquia are held fortnightly during the session. Research students are required to submit two reports on their work during each term.

The Organic Chemistry Research Laboratories open after the summer vacation in September of each year. Students, Research Fellows and others requiring accommodation are advised to make early application, preferably in the preceding February. Applications received after May will not normally be considered.

Current research topics include :—

(i) Synthesis and properties of macrocyclic substances, including colouring matters of the porphyrin and phthalocyanine groups.
(ii) Catalysed and uncatalysed hydrogen transfer systems.
(iii) Unsaturated acids and unsaturated lactones.
(iv) Anodic syntheses.
(v) Stereochemistry of catalytic hydrogenation.
(vi) Chemotherapeutic studies including the synthesis of folic acid analogues.
(vii) Polypeptide syntheses.
(viii) Organic chemistry of phosphorus.
(ix) Chemistry of thiols.

(x) Chemistry and stereochemistry of alicyclic glycols.
(xi) Anionotropic systems.
(xii) Polycyclic systems.
(xiii) Lithium alkenyls.
(xiv) Syntheses in the polyene and acetylene fields.

POSTGRADUATE COURSES.

C.447. Advanced Inorganic Analysis.

Mr. Theobald.

A course in qualitative and quantitative analysis, adapted to the special needs of individual post-graduate students, and providing particularly for instruction in the quantitative analysis of silicate rocks and minerals.

C.448. Micro-chemistry, Inorganic.

Mr. Theobald.

C.451 and **C.457. Chemistry of Food and Drugs.**

Mr. Eldridge and Mr. Hannen.

The course in the Chemistry and Microscopy of Food, Drugs and Water extends over one year or longer, and is designed primarily to prepare students for the Degree of M.Sc. (by examination) of the University of London. It may also serve as part of the requirements for admission to the examination in Branch E for the Fellowship of the Royal Institute of Chemistry. Students who desire to qualify for admission to this examination should ascertain the Institute's regulations for admission to its Associateship, and should note that in addition to the work of this course, considerable further experience in the analysis of food, drugs, etc., will be required before admission to the examination to the Fellowship.

Syllabus :—The reading course (C.451) embraces the chemistry, origin, composition, commercial preparation, and preservation of food ; adulterants and impurities ; the general principles of dietetics ; water supplies ; the chemistry (including falsification), pharmacological action, and therapeutic value of drugs ; poisons and their effects, including industrial poisoning ; the chemistry of urine ; antiseptics and disinfectants ; the Sale of Food and Drugs Acts and other Acts and Regulations relating to food, drugs, poisons, dangerous trades, etc.

The laboratory courses (C.457) comprise : chemical analysis of water, effluents, food materials and products, drugs and chemicals used in pharmacopoeial preparations and prescriptions, antiseptics, disinfectants, and urine ; toxicological analysis. Microscopical examination of water, foods, drugs, blood and urine. Recognition of commercial drugs.

Students attend short courses in Bacteriology (B.19), Biochemistry and Botany.

C.452 and **C.458. Chemistry of Water and Sewage.**

Mr. Hannen.

A course of about 7 lectures (C.452) and practical work (C.458) for post-graduate civil engineers.

C.461 and **C.467. Agricultural Chemistry.**

Mr. Pollard and Mr. Hannen.

Lectures (C.461) :—(i) 50–60 lectures given in the first half-session dealing with the formation and composition of soils, their physical properties and water relationships, and their chemistry and examination. Chemistry and manufacture of fertilisers and manures. Chemistry of plants and of plant nutrition. Application of fertilisers and manures in agricultural and horticultural practice.

(ii) A shorter course of lectures given in the second half-session dealing with the physiology and chemistry of animal nutrition ; the chemistry, preparation, and use of animal feeding-stuffs ; nutritive values ; calculation of rations for the common farm animals.

(iii) A short course of lectures given in the first half-session on the chemistry of milk, butter and cheese ; practical considerations in milk production ; variations in milk composition, their causes and significance.

Laboratory Work (C.467).—Analytical practice in connection with the above, including mechanical, physical, and chemical analysis of soils ; analysis of fertilisers, feeding-stuffs (including microscopical analysis), and dairy products ; analysis of crops and general farm materials. Students attend a short course in Bacteriology (B.19).

Research Work is mainly concerned with fundamental physical and chemical properties of soils and their nutrient status, with plant nutrition, with soil organic matter and composting, and with the fumigation of soils.

C.462 and **C.468. Chemistry of Fungicides, etc.**

Mr. Pollard and Mr. Hannen.

A course given in the second half-session, for Chemistry, Botany and Zoology students.

Lectures (C.462).—(i) (*For Chemistry, Botany and Zoology students*). The chemistry and general properties of insecticidal and fungicidal materials. Preparation and use of sprays, dusts, fumigants, etc., sheep-dips, and weed-killers.

(ii) (*For Chemistry students only*). More advanced chemical considerations of the above ; compatibility of materials, toxicity, and chemical constitution ; the examination of materials.

Laboratory Work (C.468).—(*In connection with* (i) *above*). Each lecture is followed by laboratory work illustrating essential points in the preparation of spray mixtures, etc., and the simple testing of the products.

(*In connection with* (ii) *above*). Includes the detailed analysis of preparations and materials.

Field Work.—Demonstrations in field spraying and dusting are arranged.

CHEMISTRY

FIRST YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Organic Chemistry Lecture C.131.	Mathematics M.5.	Physical Chemistry Lecture C.111.	Inorganic Chemistry Lecture C.121.	Organic Chemistry Lecture C.131.
11–12.	Chemistry Laboratory C.117, C.137 or C.147		Chemistry Laboratory C.117, C.137 or C.147	Physics P.9.	Physics P.9.
12–1.		Chemistry Laboratory C.117 or C.147		Chemistry Laboratory C.117, C.137 or C.147	Tutorial
2–3.	Chemistry Laboratory C.117, C.137 or C.147	Chemistry Laboratory C.117, C.137 or C.147	Chemistry Laboratory C.117, C.137 or C.147 or Physics Laboratory*	Chemistry Laboratory C.117, C.137 or C.147 or Physics Laboratory*	Mathematics M.5.
3–4.					Chemistry Laboratory C.117, C.137 or C.147
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Inorganic Chemistry Lecture C.121.	Physical Chemistry Lecture C.111.	Organic Chemistry Lecture C.131.	Organic Chemistry Lecture C.131.	Inorganic Chemistry Lecture C.121.
11–12.	Physical Chemistry Lecture C.111.	Chemistry Laboratory C.117orC.147	Chemistry Laboratory C.117orC.147	Physics P.9.	Physics P.9.
12–1.	Chemistry Laboratory C.117orC.147			Mathematics M.5.	Mathematics M.5.
2–3.	Chemistry Laboratory C.117orC.147	Chemistry Laboratory C.117orC.147	Chemistry Laboratory C.117orC.147 or Physics Laboratory.*	Chemistry Laboratory C.117orC.147 or Physics Laboratory.*	Mathematics M.5.
3–4.					Chemistry Laboratory C.117orC.147
4–5.					

* Students will be divided into two groups taking Physics on Wednesday and Thursday, respectively.

CHEMISTRY

SECOND YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Physical Chemistry Lecture C.211.	Physical Chemistry Lecture C.211.	Physical Chemistry Lecture C.211.	Physical Chemistry Lecture C.211.	Inorganic Chemistry Lecture C.221.
11–12.	Chemistry Laboratory C.217 or C.247.	Chemistry Laboratory C.217 or C.247.	Inorganic Chemistry Lecture C.221.	Chemistry Laboratory C.217 or C.247.	Physical Chemistry Lecture C.211.
12–1.			Chemistry Laboratory C.217 or C.247.		Chemistry Laboratory C.217 or C.247.
2–3.					
3–4.					
4–5.					

SECOND YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Organic Chemistry Lecture C.231.	Organic Chemistry Lecture C.231.	Organic Chemistry Laboratory C.237.	Organic Chemistry Laboratory C.237.	Organic Chemistry Laboratory C.237.
11–11.30.	Organic Chemistry Laboratory C.237.	Organic Chemistry Laboratory C.237.			
11.30–12.			Organic Chemistry Lecture C.231.	Organic Chemistry Lecture C.231.	Organic Chemistry Lecture C.231.
12–12.30.					
12.30–1.			Organic Chemistry Laboratory C.237.	Organic Chemistry Laboratory C.237.	Organic Chemistry Laboratory C.237.
2–3.					
3–4.					
4–5.					

DEPARTMENTS OF ENGINEERING

The five Departments of Engineering are centred in the City and Guilds College. The courses provide education in engineering science by lectures, laboratory work, drawing office practice and workshops.

Undergraduate Courses.

To qualify for entry to any undergraduate course in Engineering a student must satisfy the minimum University Entrance requirement, and pass at Advanced level of the General Certificate Examination, or of the Preliminary (Intermediate) or an approved equivalent examination in Chemistry, Physics, Pure-and-Applied Mathematics.

All undergraduate courses extend over three Post-Intermediate years.

Students will ordinarily sit for Part I of the Final Examination at the end of the first session and for Part II of that examination at the end of the second session. The award of the Degree of B.Sc. (Eng.) (London) and the Diploma of the College (A.C.G.I.) is made on these examinations and on the work of the third year which may be assessed by examination or otherwise. Further particulars of the courses and of Parts I and II of the Examinations are given later under the separate Departmental headings. It should be noted that the Time-tables shown are liable to revision, but indicate the general arrangement of the courses. Each section also gives a brief note on the laboratories and workshops of the Department concerned.

Advanced Study and Research.

Students who graduate at the College may pursue a course of advanced study or research for a period of one or more years. Graduates from other universities will also be accepted, as far as accommodation permits, provided that they are qualified to pursue these advanced courses.

The University of London awards the Degrees of M.Sc. (Eng.) and Ph.D. for research, and postgraduate students engaged in suitable work may apply for registration as students for these Degrees. The Imperial College awards a Diploma (D.I.C.) for research and/or advanced study. This Diploma is only granted to full-time students who present a satisfactory thesis or dissertation on some branch of their research or study, after not less than one year's satisfactory attendance in the College. It cannot be awarded for a course of study taken as part of the qualification for an initial Degree.

Registration for the Diploma and for a higher University Degree may be concurrent.

Regulations relating to the higher University Degrees may be obtained from the Registrar of the College.

Brief details of advanced courses of study will be found after the syllabuses for the undergraduate courses in the different Departments.

Library.

The Library of the City and Guilds College, containing about 16,000 books and bound volumes of periodicals, is open to students from 9.45 a.m. to 5.30 p.m. daily from Monday to Friday during term-time, and during Vacation at periods which will be specified at the end of each term.

Summary of Undergraduate Courses.

First Year

Aeronautical Engineering	...	Maths. M.31. Mech. Eng. M.E.1, 2, 3, 4, 5, 6. Elect. Eng. E.E.3, 4. Civil Eng. C.E.101, 102.
Chemical Engineering	...	Maths. M.32. Chem. C.148, C.122, C.132, C.112, C.118. Mech. Eng. M.E.1.
Civil Engineering	... ...	Maths. M.31. Mech. Eng. M.E.1, 2, 3, 4, 5, 6. Civil Eng. C.E.101, 102, 103. Elect. Eng. E.E.3, 4.
Electrical Engineering	...	Maths. M.31. Mech. Eng. M.E.1, 2, 3, 4, 5, 6. Elect. Eng. E.E.1, 2. Civil Eng. C.E.101, 102.
Mechanical Engineering	...	Maths. M.31. Mech. Eng. M.E.1, 2, 3, 4, 5, 6. Elect. Eng. E.E.3, 4. Civil Eng. C.E.101, 102.

Second Year

Aeronautical Engineering	...	Maths. M.33. Mech. Eng. M.E.12, 13, 14, 15, 16, 17, 18, 19. Elect. Eng. E.E.23, 24. Metallurgy Met. 13. Civil Eng. C.E.204.
Chemical Engineering	...	Maths. M.33. Metallurgy Met.13. Mech. Eng. M.E.2, 5, 7, 8, 9, 10, 11, 30. Elect. Eng. E.E.5, 6.
Civil Engineering	... ...	Maths. M.33. Civil Eng. 201, 202, 203. Geology G.40, 41, 42, 43. Mech. Eng. M.E.13, 20.
Electrical Engineering	...	Maths. M.33. Mech. Eng. M.E.13, 21, 22, 23. Elect. Eng. E.E.11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22.

Mechanical Engineering	...	Maths. M.33. Mech. Eng. M.E. 12, 13, 14, 15, 16, 17, 18, 19. Elect. Eng. E.E.23, 24. Metallurgy Met. 13. Civil Eng. C.E.204.

THIRD YEAR

Aeronautical Engineering	...	Aerodynamics. Aeronautical Structures. Aircraft Design (including Materials). Aircraft Propulsion. Mathematics.
Chemical Engineering	...	Chem. Eng. Ch.E.4, 8, 14, 16, 17. Civil Eng. C.E.309.
Civil Engineering ...	...	Maths. M.34. Civil Eng. C.E.301 to 310. Geology G.44. Metallurgy Met. 13. Botany B.21.
Electrical Engineering	...	Elect. Eng. 25, 26, 27, 28, 29. Maths. M.34. Metallurgy Met. 13.
Mechanical Engineering	...	Mech. Eng. M.E.24, 25, 26, 27, 28, 29, 30, 31. Maths. M.34. Civil Eng. C.E.308.

General Lectures.

12 noon to 1 p.m. on Mondays.

DEPARTMENT OF AERONAUTICS

The Aeronautics Department occupies part of the Goldsmith's extension in the City and Guilds College.

The Aerodynamics Laboratory is equipped with—

(1) A 5 ft. by 4 ft. closed section return circuit wind tunnel.

(2) A fluid motion return circuit wind tunnel having a special working section 5 ft. by 1 ft.. 10 ft. long, under continuous suction.

(3) A 9 ins. by 3 ins. high speed wind tunnel, capable of speeds up to 1,500 m.p.h.

(4) A small wind tunnel in which smoke is used to display the flow of air is available.

Experiments designed to illustrate aerodynamic phenomena, and to familiarise the student with the more important experimental techniques used in aerodynamic work are carried out with the above equipment.

The Aircraft Structures Laboratory of this Department is the only one at any British University solely developed for experimental investigation and research in Aircraft Structures.

This Laboratory is equipped i.a. with—

(1) A number of small frames to measure the deformation and stresses in closed and open tubes.

(2) An electrically operated structural test frame to investigate wings and fuselages.

(3) Specially developed Strain-gauge equipment for measuring small and large strains.

(4) An electrically operated panel testing machine.

(5) A combined static and dynamic (up to 1000 cycles p.m.) testing machine for compression, tension and bending and loads up to 60 tons.

A number of specimens tested are redux-jointed.

The student has opportunity to make use of the latest structures experimental techniques.

For instruction on the characteristics of aircraft and in flight experimental technique, use is made of a two-seat glider, launched by winch or aircraft-tug, in which students, accompanied by an instructor, are able to carry out experiments in flight. Arrangements also exist with aircraft firms in the London area whereby students take part, from time to time, in experimental flight testing on large aircraft. Flight experimental work for students is optional.

The Aeronautics Library contains a wide selection of works on aeronautics and related subjects. It holds and maintains a full collection of reports on aeronautical matters issued by the more important research and development laboratories or agencies throughout the world.

The Departmental Workshop is equipped for the manufacture of precision apparatus. A section of the workshop is used by research students for making their own apparatus.

Undergraduate Course.

(*a*) *Internal Students of Engineering.*

Students who are proceeding to the degree of B.Sc. (Eng.) and/or the Associateship of the College (A.C.G.I.), and who wish to specialise in Aeronautics (Aeronautical Science and Engineering), spend their first two years after passing, or obtaining exemption from the Intermediate Examination, in a study of general engineering subjects, following a syllabus identical with that for the First and Second undergraduate years in Mechanical Engineering (pages 149–154). Having passed the Part I and Part II examinations for the degree, and/or Associateship, they proceed to Part III in Aeronautical Engineering, taking the third year undergraduate course, as set out in detail below.

(*b*) *Internal Students of Physics or Mathematics.*

The third year undergraduate course is also open, in whole or in part. to students who have qualified in Physics or Mathematics.

Students proceeding to a degree in Physics may spend their third undergraduate year in the Aeronautics Department.

(*c*) *Direct Entry to Third Year Undergraduate Course.*

Students who have suitable qualifications in Engineering, Physics or Mathematics may make a direct entrance into the whole, or parts of the third year undergraduate course.

Students of Engineering, Physics or Mathematics at other Colleges of the University of London are admitted to the whole or to parts of the course, provided the permission of their College is granted.

Postgraduate Course.

The Department provides a one-year postgraduate course in advanced aspects of Aeronautical Science and Engineering.

This course is open, in whole or in part, to students who have completed the third year undergraduate course, or such parts of it as are required for a satisfactory study of those parts of the post-graduate course which they wish to take.

The course is also open to students who have suitable qualifications, provided they have passed through a course in Aeronautics equivalent to the third year course, or to such parts of it as are deemed necessary by the Professor of Aviation for a satisfactory study of those parts of the postgraduate course which they wish to take.

Part-Time Students From Industry.

Facilities are provided to enable technical staff of industrial concerns to attend courses on a part-time basis.

Research Work.

The Department provides facilities and supervision for students who wish to engage in research work in aeronautical subjects.

Syllabus : Third Year Undergraduate Course

A course of lectures, exercises classes, private tuition periods, and, where applicable, laboratory classes and drawing office classes, is provided in each subject. The approach is based on fundamentals ;

it aims at a full physical understanding of phenomena and at a sound analytical treatment.

Aerodynamics.

Theorems of momentum and energy. Dynamical similarity ; use of models ; scale effect. Theory of flow of inviscid and incompressible fluids ; aeronautical applications ; theory of aerofoils. Vortex theory ; theory of wings ; corrections in wind tunnels. Theory and practice of flow of viscous fluids ; equations of motion. Boundary layers ; laminar condition ; turbulent condition ; transition ; equations of motion ; momentum considerations ; control of boundary layer ; drag of aerofoils. Elementary treatment of flow of compressible fluids ; linear theory of subsonic and supersonic flow ; shock waves ; transonic conditions.

Aircraft Performance and Aerodynamic Design.

Aerodynamic components of aircraft. Effects of geometry and scale on aerodynamic characteristics. Behaviour of controls.

Estimation of weight and drag. Determination of performance characteristics of aircraft. Range estimates. Take-off and landing performance. Turning performance.

Technique of aerodynamic design of aircraft. Desirable features, and influences governing choice of characteristics for low and high speed aeroplanes, and tail-less aeroplanes.

Stability and Control of Aircraft.

Elementary theory of the dynamics of aircraft. Equations of motion. Aerodynamic derivatives. Stability of steady symmetric flight. Elementary theory of longitudinal control and manoeuvre. Effects due to gusts.

Theory of Structures (Aircraft).

Revision of elementary principles ; engineers' theory of beams ; Euler buckling of struts ; frameworks ; moment distribution methods.

Principles of stressed skin structures. Two-and-three-dimensional stress systems. Energy theorems. Thin-walled closed tubes under torsion and bending ; statically equivalent and self-equilibrating stress systems ; engineers' theory of bending and Bredt-Batho theory of torsion ; flexural axis ; axial constraints stresses. Thin-walled open tubes ; torsion bending theory of Wagner-Kappus. The four-boom closed and open tube ; zero-warping axis. Multi-cell tubes ; conical tubes. Effect of rib deformability. Diffusion at cut-outs. Primary instability of thin-walled struts ; flexural-cum-torsional instability. Local instability. Plates under transverse and end loads ; instability ; stiffness of plates after buckling. Initial instability and flexural failure of panels. Dynamic effects in structures ; natural modes of vibration ; use of models.

Airworthiness.

Structural components of aircraft. Aerodynamic loads. Inertia loads. Aircraft in symmetrical steady and accelerated flight ; flight envelope. Manoeuvre loads. Asymmetric flight. Gust loads. Landing and ground manoeuvring loads. Strength requirements ; proof and ultimate factors. Elementary aeroelasticity ; control reversal ; divergence ; stiffness requirements ; resonance tests. Experimental techniques in aircraft structures ; panel testing ; wing testing ; strain gauges. Empirical methods in aircraft structures ; spar webs in incomplete tension field ; Stress-strain relations of light-alloys. Weight prediction.

Aeroelasticity.

Divergence. Vibration of non-conservative systems ; flutter : kinematical, mechanical and aerodynamical aspects ; degrees of freedom ; damping. Flutter prediction ; wing flexural-torsional binary flutter ; control and tail flutter.

Aircraft Propulsion.

(*a*) *Prime Movers.*

Piston engines ; fuels ; combustion ; carburation ; supercharging ; air and liquid cooling ; radiators ; performance at altitude.

Turbine engines ; theory of simple, regenerative, and reheat cycles ; principles of centrifugal and axial compressors ; turbines ; combustion ; mechanical design. Performance of simple jet, and propeller-turbine engines.

Rocket engines. Ram-jets.

(*b*) *Propellers and Fans.*

Theory of propellers and fans. Performance. Conditions for maximum efficiency. Design.

Experimental Methods and Instruments.

Visualisation of flow at low and high speeds. Photographic techniques. Measurement of airspeed ; pressure instruments ; hot wire anemometers. Wind tunnels for subsonic and supersonic work ; design ; energy ratio ; errors and corrections. Gyroscopic instruments. Data transmission systems. Computing systems ; analogue and digital methods. Automatic control systems. Measurement of strain.

Aircraft Design.

Engineering design of aircraft ; factors affecting design ; economics of aircraft ; detail design.

Properties of materials used in aircraft construction.

Syllabus : Postgraduate Course

The Postgraduate Course occupies one year. The course may be taken in whole or in part. Students may also take courses given in the other Departments of the College and in other Colleges of the University, when such courses have a bearing on their studies.

Candidates who wish to qualify for the award of the Diploma of Membership of the Imperial College (D.I.C.) by the study of this course will be required to submit a dissertation or a design, relating to an approved subject, which they have investigated during their period of study.

Students of the Postgraduate Course may be required, or may wish, to attend courses in the Third Year Undergraduate Syllabus. Time-tables are arranged to permit this.

A course of lectures, exercise classes, and, where applicable, laboratory classes and drawing office classes, is provided in each subject.

The standard of the courses is advanced, and a knowledge of the appropriate parts of the third year undergraduate courses is assumed as a starting point.

Aircraft Design.

A course in which the student evolves the design of an aircraft, with assistance and direction. The course is designed to familiarise the student with the processes of design, with airworthiness and design requirements, and with the application of aerodynamic, structural and thermodynamic theory in aircraft design.

The Theory of Aerofoil Design.

(*a*) *Advanced Potential Flow.*

Inviscid fluid flow : general theorems. Two-dimensional flow : use of complex potential theory. Advanced types of flow : free streamlines. The Hodograph plane and its uses.

(*b*) *Application to Aerofoils.*

Potential flow around aerofoils, cascades and channels : Theordorsen's theory : Goldstein's approximations. Design : exact and numerical methods.

(*c*) *Practical Design Considerations.*

Full-scale requirements and their interpretation. C_L-range theory : high speed questions : camber : maximum lift coefficient : drag. The boundary-layer : low-drag aerofoils : control by slots and porous surfaces. Experimental results.

Boundary-Layer Theory.

(*a*) *General Viscous Flow.*

Formulation of equations of motion : stress and rate-of-strain tensors. General theorems. Compressible fluid : temperature, energy, pressure. Boundary conditions. Exact solutions. The boundary-layer conception.

(*b*) *Laminar Boundary Layer in Incompressible Flow.*

Prandtl's equation of motion : its assumption and implications. Exact solutions. Approixmate methods of solution : series : momentum equation. Drag estimation. Wakes. Control by suction slots and porous surfaces. Stability theory. Unsteady flows.

(*c*) *Turbulent Boundary Layer in Incompressible Flow.*

Reynold stresses ; means ; correlation coefficients ; isotropy. Hypotheses ; mixture length and transfer theories. Experimental results and empirical formulae. Pipe flow.

(*d*) *Boundary Layers in Compressible Flow.*

The approximations. Methods of solution and various assumptions. Insulated boundaries. Temperature-velocity relations. Exact and approximate solutions. Limitations of theory. Heat transfer.

Dynamics of Compressible Fluids and Supersonic Aerodynamics.

Isentropic compressible flow. Propagation of disturbances ; formation of shock waves ; influence of viscosity and conductivity ; properties of shock waves ; reflection and combination of shock waves. Subsonic flow ; treatment of two and three dimensional flow ; small perturbation methods ; exact solutions ; hodograph methods. Theory of aerofoils and wings in subsonic flow ; experimental results. Transonic flow ; small perturbation theory ; experimental results ; Supersonic flow ; small perturbation theory ; Prandtl-Meyer expansion ; method of characteristics ; application to solutions of flow around bodies. Aerofoils and wings in supersonic flow ; lift and drag ; influence of section and planform ; experimental results. Unsteady supersonic flow. Viscous effects in high speed flow ; interaction of shock waves and boundary layer. Problems of high speed flight ; aerodynamic problems of transonic and supersonic aircraft.

Turbulence.

Turbulent stresses in fluid flow. Mixing length theories ; application of boundary layers, jets and wakes. Statistical theory of turbulence ; decay of isotropic turbulence ; spectrum of turbulence. Wind tunnel turbulence ; design of low-turbulence wind tunnels. Experimental methods.

Advanced Theory of Aircraft Structures.

Advanced theory of wing stressing ; conical tubes with dissimilar distribution of material ; idealisations ; three-joint equations for the boom load function in four-boom tubes ; effect of rib deformability ; five-joint equations. Advanced treatment of conical multi-boom tubes ; self-equilibrating orthogonal load systems ; axes of twist. Diffusion in flat panels. Non-conical tubes. Open multi-boom tubes. Ring deformability and fuselage stressing. Advanced examples of initial instability of flat panels ; effect of torsional cum local deformation of stringer. The Foeppl-Karman equations of post buckling behaviour of flat plates ; energy method. Failure of flat panels in compression. Curved plate in compression ; post buckling behaviour and initial instability. Failure of curved panels in compression ; hoop stresses in fuselages. Elements of incomplete tension fields in curved panels. Dynamic effects in aircraft structures ; more advanced analysis ; structural effects of gusts.

Advanced Aeroelasticity.

Lagrangian equations for holonomic and non-holonomic systems. Viscous and structural damping. Dissipation function.

Advanced treatment of divergence and flutter ; typical ternary analysis ; flutter determinants ; mechanical admittances and flutter ; applications to wings, tail, controls, tabs, propellers. Aeroelasticity in transonic and supersonic regimes.

Advanced Theory of Stability and Control of Aeroplanes.

Linearised equations of motion of aircraft with controls free. Solutions by the method of Laplace Transforms. Routine computing methods. Damping and frequency diagrams and their interpretation. The behaviour of aeroplanes with generalised automatic controls ; analysis and synthesis. Mechanical and aerodynamic servos. Electro-mechanical analogies.

Aerodynamic derivatives : calculation by lifting line and lifting surface methods. Experimental techniques. Special problems of stability and control at low speed, in gusts and at high speeds. Advanced theory of control and manoeuvre. Stability and control of all-wing aircraft. Stability problems of supersonic aircraft.

DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY

The Chemical Engineering and Applied Chemistry building in Prince Consort Road accommodates the work of Chemical Technology (including Fuel and Refractories Technology), Applied Physical Chemistry and Chemical Engineering. It comprises, besides a lecture room, drawing office, workshops and stores, large laboratories specially equipped for advanced study and research.

In connection with the major researches in progress in the Department, there is a variety of unique equipment available, much of which has been designed by the staff and students and constructed in the Departmental workshops. This includes high speed cameras, electron diffraction cameras and electron microscopes, high pressure autoclaves and reaction vessels for work up to 15,000 atmospheres, liquefaction plant, spark ignition and compression ignition engines, a range of quartz spectographs, an X-ray set, a variety of high temperature furnaces, high vacuum pumps, gas compressors and a range of accurate measuring and recording instruments.

The Chemical Engineering laboratories are equipped with pilot plant for the quantitative experimental study of unit operations and for original investigations into the mechanism of fundamental processes.

The Department has three fully equipped workshops and a staff of trained mechanics.

The resources of the Department for advanced study and research will be at the disposal, on proper terms and conditions, of any duly qualified person who, having satisfied the College authorities of his ability to use them with advantage, is willing to collaborate with the staff in investigations likely to benefit industry.

Courses of Study.

The Department provides an Undergraduate Course in Chemical Engineering and Postgraduate Courses in Chemical Engineering, Applied Physical Chemistry and in various branches of Chemical Technology (Fuel, Refractories, Combustion of Gases, Blast Furnace Reactions, Low Temperature Production and Utilisation).

The Postgraduate Courses are intended for students who have already passed through a systematic training extending over not less than three years in certain principal and subsidiary subjects, particulars of which are given later, and have either graduated A.R.C.S. or B.Sc. or attained some other equivalent standard either at the Imperial College or elsewhere.

The object of the courses is to give students a broad and practical training for responsible positions in industry requiring a working knowledge of their principal subject, in addition to an intelligent grasp of the economic factors of production. It is not intended to occupy a large portion of the courses with the details of chemical manufacture, or to teach the actual practice of particular industries, but rather to expound the principles underlying manufacturing processes with illustrations freely drawn from practice.

The Departmental Laboratories provide extensive accommodation for investigations and research work covering the subjects dealt with in the Postgraduate Courses. In addition there are a number of laboratories equipped to afford training in special techniques, e.g., electro-thermics, electron diffraction and microscopy, high pressure reactions, spectrographic study of flames, combustion in the internal combustion engine and low temperature technology.

Vacation courses are arranged for students wishing to obtain works experience during the long vacation and visits to gas works, coke ovens and other chemical works are arranged during term-time.

Undergraduate Course.

The Undergraduate Course in Chemical Engineering extends over three post-intermediate years.

The Diploma of the City and Guilds of London Institute (A.C.G.I.) is awarded upon the recommendation of the Delegacy to those students who have satisfactorily pursued the Diploma Course in Chemical Engineering in the City and Guilds College, and have creditably passed the examinations.

The Degree of B.Sc. (Eng.) in Chem. Eng. is awarded on the same courses to students who are registered as Internal Students of the University of London and who qualify for the Diploma.

Examinations are held during and at the end of the Session, *see* pp. 57–58.

Students are required to provide themselves with drawing instruments. Information as to the instruments and tools required is given to the student on entering the College.

First (Post-Intermediate) Year.

First Year students take courses in Machine Drawing in the Mechanical Engineering Department.

Inorganic, Organic and Physical Chemistry—in the Chemistry Department.

Mathematics and Mechanics—in the Mathematics Department.

Second (Post-Intermediate) Year.

Second Year students take courses in Workshop Practice, Strength Strength of Materials, Heat Engines, Heat Transfer, Mechanisms and Hydraulics in the Mechanical Engineering Department.

Mathematics—in the Mathematics Department.

Electrical Engineering—in the Electrical Engineering Department.

Setting out of Works—in the Civil Engineering Department.

Metallurgy—in the Metallurgy Department.

Third (Post-Intermediate) Year.

Third year students take the following courses :

Fuel Technology and Furnace Design, Refractories and Silicate Technology, Applied Thermodynamics, Materials of Construction,

Chemical Plant Design and Construction, Economics and General Chemical Engineering—in the Chemical Engineering Department.

The courses consist of lectures and tutorial classes, together with experimental work in the laboratories of the various Departments concerned.

Special Course for Third Year Metallurgical Students.

This includes special courses in Fuel Technology and Refractories Technology.

Postgraduate Courses.

A student who has satisfactorily completed the course in Chemistry and/or Physics for the Associateship of the Royal College of Science, or in Mechanical Engineering or Chemical Engineering for the Diploma of the City and Guilds of London Institute, or who satisfies the College authorities that he has done equivalent work elsewhere*, may apply to enter upon a systematic course of postgraduate study and/or research in the Department extending over one or more years, whereby he may become eligible for the D.I.C. (Diploma of the Imperial College) and/or for a higher Degree of London University.

The Diploma is granted for advanced study and research, or for research only. A student electing to take the Diploma by advanced study and research must choose, according to his requirements and after consultation with the professors and teachers concerned, a principal and one subsidiary subject from among Chemical Engineering, Fuel Technology and Refractories Technology and must pass an examination in these subjects at the end of his first postgraduate year.

In order to become eligible for the Diploma a period of two years postgraduate work is usually required, at the end of which the student will be expected to present a thesis or dissertation embodying the results of his work.

A student may (if he so desires and is otherwise qualified) apply for registration for either (i) the M.Sc. Degree of London University or (ii) the London Ph.D. Degree in the subject of his study and research.

The Head of the Department will meet all new students at the opening of the Session for the purpose of advising them upon their courses of study. He may also be consulted thereon at any time convenient during the Session, and should be informed if and when any change in course is desired.

Industrial Research Fellowships.

The following Research Fellowships have been established by industrial firms and Research Associations in connection with the Department for the purpose of enabling students who have successfully passed the First Year Postgraduate Course (or its equivalent) to

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* In the case of a student entering for postgraduate work in Refractories Technology his principal subject may have been Chemistry, Physics, Geology, Metallurgy, Chemical or Mechanical Engineering.

undergo two years' training in fundamental research with a view to subsequent employment in industry :—

Two Gas Research Fellowships established by the North Thames Gas Board and Radiation, Ltd., London, respectively. Each Fellowship is tenable for two years.

A Studentship for Postgraduate training in Chemical Engineering, established by the Trustees of the late Viscount Leverhulme. Awarded in the first instance for one year but renewable for a second year.

A Viscount Wakefield Research Scholarship, in Applied Physical Chemistry, provided by Messrs. C. C. Wakefield & Co., Ltd.

One Research Scholarship in Chemical Engineering, provided by Messrs. Federated Foundries, Ltd.

Postgraduate—First Year.

According to his choice, throughout the Session, a student electing to take advanced study or advanced study and research will usually attend lectures and will carry out laboratory work of a formal character, in both principal and subsidiary subjects. According to his course of study and progress therein at the end of the first half-session, or later, he may be attached to one or other of the various research groups in his principal subject.

Postgraduate—Second and Subsequent Years.

These may be spent in one of the following ways, according to individual requirements and circumstances :—

(*a*) In further specialised advanced study and/or research at the Imperial College in one or more subjects arising out of the first year's course, *or*

(*b*) In studying systematically the economic factors of a special branch of chemical industry in any manner approved by the Head of the Department.

Research Work.

The research activities of the Department include the following groups of investigations :—

Combustion.—Kinetics, Propagation of Flame, Detonation, Spectrograph Analysis, Internal Combustion Engine.

Fuel Technology.—The Chemical Composition and Constitution of Oil-Shales and related materials. Methods for the analysis of High-Ash Coals and the like.

Gas Analysis.

High Pressure Reactions.—Determination of Equilibrium Constants, Transition Points, Polymerisation, etc., in condensed systems.

Low Temperature Technology.—Equilibrium in Multi-Component Systems at Low Temperatures, Thermal Properties of Binary Systems, Distillation and Heat Transmission at Low Temperatures.

Applied Physical Chemistry.—Surface Chemistry and Physics, Crystal Growth, Surface and thin film structure of plastics, Structure of dusts, Thermionic and Photo-electric Emission, Electro-deposition, Catalysis, Corrosion, Mechanical Wear and Lubrication.

Refractories Technology.—Thermal properties of Refractory materials, Properties of Silicate Systems at High Temperatures.

Chemical Engineering.—Flow of Fluids and Slurries, Two Phase Separation Processes, Mechanism of Drying of Solids, and Evaporation of Liquids, Pneumatic Conveying, Air-Lift Pumping, Mechanism of Mixing Processes, Properties of Sprays and Mists.

CHEMICAL TECHNOLOGY. (FUEL TECHNOLOGY, REFRACTORIES TECHNOLOGY, COMBUSTION OF GASES, CHEMICAL THERMODYNAMICS, BLAST FURNACE TECHNOLOGY.)

Dr. Himus, Mr. Barrett, Dr. Burgoyne, Dr. Strickland Constable, and Dr. H. L. Saunders.

Ch. E.1. Fuel Technology Lectures.

Fuel Technology, Part I.

Introductory and General.

Lectures during the first term (October to December).

Review of the world's fuel resources and the principal economic uses thereof. Chemical compositions and the comparative values of the principal solid, liquid and gaseous fuels.

The origin, geological distribution and proximate and ultimate constituents of coals. Classification of coals and their selection for steam raising, domestic heating, gas making, and the manufacture of metallurgical coke. Composition of the ashes of solid fuels; "clinker" formation. Brown coals and lignites; bituminous coals and anthracites. The thermal decomposition of coals, low and high temperature products. Oxidation and hydrogenation of the coal substance. Views as to the constitution and "maturing" of coals.

Fuel Technology, Part II.

Lectures during the second and third terms (January to June). A selection of the following subjects will be treated.

A. The Production and Utilisation of Steam.—Principles of the operation of boilers, types of boilers, auxiliary plant, use of steam for power production and process work.

B. Carbonisation of Coal.—A general study of the methods employed in the carbonisation of coal, at temperatures between 500 and 1,200 deg. C., including the recovery of the by-products. The Coal Gas and Coking Industries. Standards of public gas supplies.

C. Gas Producer Practice.—The chemistry of the complete gasification of solid fuels by means of an air or air-steam blast. The design and construction of the generator; influence of relative proportions of air and steam upon the composition of the gas; ammonia recovery practice. The cooling and cleaning of gas for power purposes. Water gas.

D. Fuel Economy in Blast Furnace Practice and the Manufacture of Steel.

E. Fuel Economy in Furnaces.

F. Liquid Fuels.—The occurrence, distribution, production, transportation and refining of petroleum. Shale oil. Physical and Chemical testing of fuel oils. Oil fuel burners. Application of fuel oil to steam raising, and furnaces generally.

G. Coal as a source of Liquid Fuels.

Ch.E.2. Fuel Technology for Metallurgical Students.

Fuel Technology, Part III.

A special course of lectures, at times to be arranged during the second half-session, with special reference to the manufacture and properties of metallurgical coke, gas-producer practice, and blast furnace fuel economy.

Ch.E.3. Fuel Technology Laboratory.

A. Students specialising in Fuel Technology will, during the first two terms of their course, attend each day the Fuel Analytical Laboratories, except for such period (not exceeding six weeks) as they may do laboratory work in their subsidiary subject. Their work will be selected from the following subjects: Fuel analysis and calorimetry, technical pyrometry, gas analysis. Testing the properties of coals and yields of various distillation products at low and high temperatures. Determination of sulphur, nitrogen and phosphorus in coal. Examination and distillation of tar and ammoniacal liquors, the refining of tar products. The chemical and physical examination of liquid fuels (alcohol, benzol, petrol and fuel and lubricating oils, etc.).

Students taking Fuel Technology as a subsidiary subject, will attend the Fuel Analytical Laboratories during the first six weeks (October and November) of the session for a shorter course of experimental work selected from the foregoing.

B. If required, a special laboratory course for Engineering and Metallurgical students will be held during the second half-session for instruction in the commercial examination of fuels, and cognate subjects.

C. Special facilities are provided in the research laboratories for advanced study and investigation of such subjects as the chemistry of coal, the mechanism of combustion, ignition phenomena and the initial movements of flame through explosive mixtures, gaseous explosions, surface combustion, gaseous combustion and reactions under high pressures, combustion in spark ignition and compression ignition engines, flame spectrometry, the fractionating and refining of liquid fuels, heat balances, pyrometry, radiometry, metallurgical reactions, thermochemistry, cryogenics, etc.

Ch.E.4. Fuel Technology for Chemical Engineering Students.
Dr. Himus.

Lectures during the first term.

The meaning of, and the necessity for economy in the use of fuel. Fuels, primary and derived. Combustion and calorific values of solid, liquid and gaseous fuels. The relative importance and fields of utility of each. Factors involved in the selection of fuels for various purposes.

The origin and formation of coal ; composition of the coal substance ; classification. Impurities associated with the coal substance. Mineral matter in coal ; relation of the mineral matter to the ash ; formation of clinker. The cleaning of coal.

The purposes for which coal is used in Great Britain. Reserves of coal.

Combustion ; burning of coal on grates ; air required. Hand and mechanical firing. Combustion calculations ; flue gas calculations ; undeveloped heat.

Steam raising ; principles involved. Types of boilers ; auxiliary plant. Economic raising of steam ; efficient management of boilers ; boiler trials.

Pulverised coal and oil-coal mixtures.

Utilisation of steam on the works ; steam for the production of power ; process steam ; power as a by-product.

Producer-gas ; principles of its manufacture ; types of gas-producer. Application for firing furnaces and the production of power. Water-gas ; nature of, and the principles of its manufacture. Carburetted water-gas and its uses.

Fuel economy in the operation of furnaces. Range of operations in terms of size of furnace and temperature required ; methods of operation. Selection of fuels. Heat required. "Available heat" and how it may be increased. Calculation of the heat requirements of a simple furnace. Importance of loading, insulation, etc., in the saving of fuel.

Laboratory.—Proximate analysis of coal ; determination of sulphur ; examination for washability. Use of the bomb calorimeter for determination of calorific value of solid or liquid fuels. Gas calorimetry. Examination of liquid fuels. Low temperature carbonisation assay of coal or oil-shale. Analysis of air ; flue gases for carbon dioxide, oxygen and carbon monoxide. Calibration of a thermo-junction.

Combustion of Gases.

Ch.E.5. Gaseous Reactions leading to Ignition.
Dr. Burgoyne.

A course of about 10 lectures, given during the first term.

Evolution of modern views of combustion reactions ; elements of kinetics and chain theory ; detailed consideration of reactions with oxygen of hydrogen, carbon monoxide, hydrocarbons and associated compounds.

Ch.E.6. Ignition and Flame Propagation in Gases.

Dr. Burgoyne, Mr. Fraser.

A course of about 12 lectures, given during the second term.

Ignition of gases by thermal and electrical sources ; limits of inflammability ; flame speeds and detonation ; stationary flames ; flame temperatures and explosion pressures.

Ch.E.7. Applications of Spectroscopy to Combustion Problems.

Dr. Gaydon.

A course of about 5 lectures, given during the second term.

Elementary theory of molecular spectra ; experimental technique ; banded emission spectra of flames, explosions and engines ; low pressure flames, cool flames ; continuous spectra ; test for atomic oxygen ; halogen, sulphur and nitrogen compounds in flames ; carbon formation ; absorption and infra-red emission ; measurement of flame temperature ; equipartition of energy ; afterburning.

Ch.E.8. Industrial Explosion and Fire Hazards.

Dr. Burgoyne.

A course of 6 lectures for Chemical Engineering students given during the third term.

Thermal and electrical ignition of gases ; control of igniting sources. Limits of inflammability ; flame movement ; explosions in confined spaces ; explosion venting ; flameproof enclosure. Mist and dust explosions. Fire hazards of materials and buildings.

Ch.E.9. Chemical Thermodynamics.

Dr. Strickland-Constable.

Advanced Thermodynamic subjects (graduates).

Blast Furnace Technology.

Ch.E.10. Blast Furnace Technology.

Dr. H. L. Saunders.

A course of about 10 lectures given during the second half-session.

General construction and evolution of the blast furnace.

Raw materials, general considerations, home and foreign ores, coke, air blast, limestone.

Reactions relating to the process in stack, bosh and hearth, theoretical and practical coke requirements, materials and heat balance, problem of indirect and direct reduction and solution loss, significance of blast preheating, top gas temperature and composition.

Laboratory studies of reactions between gases and solids, equilibrium in systems Fe_xO_y-CO-CO_2 ; $Fe_xO_yH_2H_2O$, general limiting conditions, significance of carbon pick up.

Laboratory studies of high temperature reactions, reaction rate in relation to temperature and pressure and influence of driving rate.

The process from the practical standpoint, sampling and observation on a full scale furnace in operation, limitations of field tests, development of experimental furnace and some of the results obtained.

Significance of the coke rate, the dual function of the furnace in supplying metal and gas for steelworks.

Factors influencing economy, burden preparation and distribution, main sources of loss, flue dust, non uniform blast flow and unsuitable temperature gradient, reduction of segregation by special charging devices and alterations of cycle.

Laboratory studies in distribution, results and their significance, the practical problems imitated and their causes anaylsed.

Ore pretreatment. Washing, magnetic roasting, calcination, sintering, modern trends.

The Greenawalt and Dwight Lloyd process, chemical and physical changes during sintering, desirable qualities of sinter and methods of testing.

The assessment of ores—porosity, reducibility and heat transfer —laboratory studies and their implications.

Refractories and Silicate Technology.

Ch.E.11. Refractory Materials.

Mr. Barrett.

Part I. Refractory Materials.

Lectures—fifteen during the first half-session.
The Refractories Industry and its relation to other industries.

A broad survey of refractory oxides, silicates, spinels, carbides, etc. ; their important physical and chemical properties.

Standard tests and the principles of sampling and testing.
The raw materials, manufacture and properties of :—

(*a*) Silica refractories.
(*b*) Alumino-silicates.
(*c*) Basic and composite refractories and spinels.
(*d*) Refractory insulating materials.
(*e*) Plumbago, carbon (coke), silicon carbide and special refractory oxides.

Refractories handled in finely divided form by the user, including ramming mixes, patching materials, coatings, cements and mortars, refractory concrete, moulding sands, etc.

Refractory aspects of furnace construction and maintenance.

Refractory usage in various industries :—

(*a*) Metallurgical industries.

(*b*) Carbonising industries.

(*c*) Steam raising and general heating.

(*d*) Ceramic industries (glass, cement, enamelling and the clay industries).

(*e*) Chemical industries.

Part II. Manufacture of Refractories and Heavy Clay Products.

Lectures—fifteen during the second half-session.

This series follows Part I and deals with the aspects of importance to the manufacturer :—

The geology, selection and improvement of refractory raw materials.

Winning and preparation of raw materials ; mixing and plasticising machinery ; analysis of making methods ; *pH* control, de-airing, plasticisers ; dry-pressing studies.

Types of dryer ; mechanism of drying and maximum safe rate for various shapes ; dryer efficiency.

Types of kiln, fuels and modes of firing ; test code for kilns ; setting height, firing schedules, phases of firing, pyrometry, selection of finishing temperature ; making faults.

Special features in the manufacture of individual refractory products, e.g. silica bricks, chrome magnesite, stabilised domomite, etc.

Manufacture of electric furnace refractories ; manufacture of refractory hollow-ware.

Works control tests ; quality control and specification ; works lay-out. Silicosis regulations.

Duties of technical managers and refractory technicians.

Part III. Silicate Technology.

Lectures—one per week throughout the session.

This course attempts to bring out the underlying principles of ceramic technology and draw attention to fundamental knowledge and investigations in progress, upon which the vigour of the ceramic industries and particularly the refractory and heavy clay industries depends. The student is expected to co-operate actively by private study and contributions of his own.

Among the topics discussed are :—

The history of ceramic industry (especially the Refractories Industry) ; the work of pioneers and the Institutions which are devoted to silicate work ; the development of refractories industries in Commonwealth and foreign countries ; the literature of ceramics ; the variety of products made.

High temperature chemistry including :—

(*a*) The melting relations of the oxides and phase equilibria studies.

(*b*) The action of heat on ceramic raw materials.

(*c*) The action of gases on refractories.

(*d*) The reaction of slags with refractories.

High temperature physics including :—

(*a*) Pyrometry and thermal properties of refractories.

(*b*) The generation and control of high temperature.

(*c*) Furnace design.

(*d*) Heat transfer within refractories.

(*e*) Surface tension, viscosity and diffusion in molten silicates.

Colloid science, especially in relation to clay and water.

The mechanical properties of ceramic materials, cold and hot, which affect the method of manufacture, the limitations of use and the causes of failure.

The mineralogy of ceramic raw materials ; the use of chemical analysis, optical and electron microscopy and X-ray diffraction to identify minerals.

A critical examination with an eye to improvement of some aspects of the manufacture and properties of refractory products.

Ch.E.12. Refractory Materials Laboratory.

A. Postgraduate students in Refractories Technology and Silicate Technology will attend the laboratory during the first half-session, except during the six weeks (or other approved period) when they will be occupied in practical work in their subsidiary subject. Their work will be arranged to cover a variety of techniques, tests and materials to give a broad acquaintance with the field of refractories technology, as a preliminary to research work or advanced study in a narrower field.

The practical work will be devoted to some of the following subjects :—

Sampling ; mechanical analysis and elutriation ; chemical, differential, thermal, petrological and X-ray examination of refractory raw materials. Casting, moulding and pressing, drying and firing under controlled conditions. Plasticity, base exchange capacity, drying rates of clays. Investigations of black-coring Measurements of refractoriness and refractoriness under load, reversible thermal expansion and resistance to thermal shock and to carbon deposition. Slag cone and pill tests, iron oxide swelling test of chrome-magnesite. Measurement of the coefficient of expansion, thermal conductivity and specific heat of refractories. Various methods of measuring high temperatures.

B The course for Metallurgy students during the second half-session is chosen from the subjects under A.

Ch.E.13. Silicate Technology for Chemical Engineering Students.

Mr. Barrett.

A course of five lectures given during the third term.

A survey of the constructional products of the ceramic industries : their chemical, thermal and mechanical properties, especially in contrast to metals.

The functions and desired properties of refractory materials compared with the service given by those available. Thermal shock and slag resistance. Specifications. Sampling and testing. Typical uses. The action of gases on refractories.

Thermal insulating materials.

Non-metallic, inorganic materials used in chemical plant construction, classified according to the bond, whether glassy or cementitious. Lutes. Glass to metal seals.

Experimental work in conjunction with the above course is taken along with the Fuel Technology Laboratory Course.

Ch.E.14. Refractory Materials for Metallurgical Students.

Mr. Barrett.

A course of twelve lectures given during the second half-session. The interdependence of the refractories and metallurgical industries. Refractories available and their cost. Sampling, standard tests. Classification of refractories. Brief accounts of the manufacturing processes with special attention to the attainment of slag and spalling resistance.

The raw materials, manufacture and properties of silica, alumino-silicate and aluminous refractories. Magnesite, chrome-magnesite and dolomite refractories, their properties and uses.

Carbon, plumbago, chrome, silicon carbide refractories.

Ramming mixes, patching materials, cements and mortars, refractory concrete, moulding sands and mixtures.

Refractory insulating materials.

Refractory aspects of furnace construction and maintenance.

Refractories for the iron and steel industry : the blast furnace and stoves, metal mixers, open hearth furnaces, arc furnaces, induction furnaces ; casting-pit refractories, Bessemer converters ; regenerators ; reheating furnaces and soaking pits ; iron and steel foundry refractories.

Refractories used in zinc and copper smelting and refining.

Producer and producer gas main linings. Refractories for boilers and coke-ovens.

Experimental work in the Refractories Laboratory accompanies the above course. (See Ch.E.12.)

CHEMICAL ENGINEERING.

Ch.E.15. Third Year and Postgraduate Chemical Engineering.

Prof. Newitt, Dr. Coulson, Dr. Richardson, Mr. Anderson, Dr. Strickland-Constable, Dr. Haselden.

A course of about 150 lectures given throughout the session.

For Third Year and Postgraduate Chemical Engineering students.

Chemical Engineering operations and processes including :—

Size Reduction.—Grinding, crushing and disintegrating : types of machines ; relation between power requirements and size reduction.

Size Separation and Grading.—Particle size analysis. Screening, elutriation, flotation, settling and magnetic separation, centrifugal separation.

Filtration.—Batch and continuous filtration equipment. Theories of filtration and washing, industrial practice. Filter aids. Use of Centrifuges.

Drying.—Theory of drying of solids ; equipment for drying solids, liquids and gases.

Evaporation.—Principles of single and multiple effect systems. Thermo-compression evaporators.

Distillation.—Theory of operation of plate and packed fractionating columns for binary and multi-component systems. Azeotropic and extractive distillation.

Refrigeration and Separation of Gases.—Use of low temperatures in chemical industry.

Mixing and Agitation.—Characteristics of equipment, power consumption, efficiency. Emulsification.

Adsorption and Absorption.—Theory and operation of packed plate and spray columns. Solvent vapour recovery.

Chemical Process Plant.—Chemical Engineering aspects of typical catalytic and other processes, e.g. nitration, sulphonation, hydrogenation, halogenation.

Instrumentation and Automatic Control of Processes.

Materials of Construction.—Properties of materials of construction with some guide as to their selection for the fabrication of chemical plant.

Transportation of Solids, Liquids and Gases.—Flow of fluids, mechanical and pneumatic conveying, elevators, pumps, air-lift pumps.

Factory Layout, Construction and Organization.—

Crystallisation.—General scientific principles of crystallisation, with applications to current types of plant.

Industrial Kinetics and Thermodynamics.—The application of kinetic and thermodynamic theory in the design of reactions on the industrial scale.

Ch.E.16. Chemical Engineering Drawing Office and Laboratory Work.

Daily throughout the session.

The objects of this course are to give students an insight into (*a*) the design of chemical plant with special reference to functional efficiency, ease of control and maintenance ; (*b*) the selection of appropriate materials of construction and the methods of fabrication ; (*c*) arrangements for recording and automatically controlling materials supply, temperature, pressure, humidity, density, etc., and (*d*) the selection and specification of auxiliary equipment.

The work in the Drawing Office includes the design of simple units of plant such as heat exchangers, stills and reactors to meet specified requirements. The preparation of material, energy and time flow sheets.

The laboratories are equipped with small-scale plant suitable for the quantitative study of mass and heat transfer, measurement of fluid flow, elutriation, sedimentation, mixing, particle size analysis. The equipment includes filter presses, vacuum driers, evaporators, crushers, ball mills, fractionating columns, absorption towers, pneumatic conveyors and elevators.

APPLIED PHYSICAL CHEMISTRY.

Dr. Wilman.

The courses in this section of the Department are specially directed to recent developments in the applications of electrical and surface phenomena in industry. Special attention is given to (i) the problems of heterogeneous catalysis, thermionic and photoelectric emission, (ii) electro-chemical processes such as the deposition and extraction of metals, oxidation and reduction, and electrothermics, and (iii) the wear, corrosion and protection of surfaces. Exceptional laboratory facilities are available for fundamental studies in these and other fields. These include a number of electron diffraction cameras and an electron microscope.

Ch.E.17. Applied Physical Chemistry Lectures.

Lectures throughout the session.

Electron diffraction and surface structure. The phenomena of the diffraction of electrons and their applications to the study of problems associated with the structure of surfaces. Electron-microscopy.

Ch.E.18. Laboratory of Applied Physical Chemistry.

In keeping with the postgraduate nature of this Department, the student is encouraged to work in the laboratory on some specific problem or problems, rather than merely to carry out experiments of a more or less routine character. In this way the student not only becomes familiar with electrical and other methods of measurement, control and manufacture, but also enjoys the most favourable opportunities of broadening his knowledge and developing his independent critical faculties. In addition to research work of a fundamental character and covering a wide field, problems connected with established industrial processes are also investigated in the laboratory.

CHEMICAL ENGINEERING

FIRST YEAR

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
		First Half-Session.			
10–11.	Mathematics Lecture and Tutorial M.32.	Organic Chemistry Lecture C.132.	Physical Chemistry Lecture C.112.	Mathematics Lecture M.32.	Inorganic Chemistry Lecture C.122.
11–12.		Physical Chemistry Lecture C.112.	Organic Chemistry Lecture C.132.	Physical Chemistry Lecture C.112.	Chemistry Laboratory C.118 or C.138.
12–1.	Chemistry Laboratory C.118 or C.138.	Engineering Drawing M.E.1.	Chemistry Laboratroy C.118 or C.138.	Engineering Drawing M.E.1.	Chemistry Laboratroy C.118 or C.138.
2–3.	Chemistry Laboratory C.118 or C.138.	Physical Chemistry Lecture C.112.	Chemistry Laboratory C.118 or C.138.	Engineering Drawing M.E.1.	Chemistry Laboratory C.118 or C.138.
3–4.		Mathematics Tutorial M.32.			
4–5.					
		Second Half-Session.			
10–11.	Mathematics Lecture and Tutorial M.32.	Physical Chemistry Lecture C.112.	Physical Chemistry Lecture C.112.	Mathematics Lecture M.32.	Organic Chemistry Lecture C.132.
11–12.		Organic Chemistry Lecture C.132.	Chemistry Laboratory C.118 or 3.148.	Inorganic Chemistry Lecture C.122.	Physical Chemistry Lecture C.112.
12–1.	Chemistry Laboratory C.118 or C.148.	Engineering Drawing M.E.1.	Chemistry Laboratory C.118 or C.148.	Engineering Drawing M.E.1.	Chemistry Laboratory C.118 or C.148.
2–3.	Chemistry Laboratory C.118 or C.148.	Physical Chemistry Lecture C.112.	Chemistry Laboratory C.118 or C.148.	Engineering Drawing M.E.1.	Chemistry Laboratory C.118 or C.148.
3–4.		Mathematics Tutorial M.32.			
4–5.					

CHEMICAL ENGINEERING

SECOND YEAR

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Autumn Term.			
10–11.	Electrical Tutorial	Design M.E.11.	Applied Electricity Lecture E.E.5.	Mathematics Tutorial M.33.	Mechanical Engineering Laboratory M.E.10.
11–12.	Applied Electricity E.E.5.		Strength of Materials M.E.7.	Mathematics Lecture M.33.	
12–1.	Special Lecture			Fluid Mechanics M.E.9.	
2–3.	Workshop	Theory of Machines M.E.5.	—	Applied Thermo-dynamics M.E.8.	Mathematics Tutorial M.33.
3–4.				Fluid Mechanics Tutorial M.E.9.	Mathematics Lecture
4–5.				Mathematics Tutorial M.33.	Applied Thermo-dynamics Tutorial M.E.8.
		Spring Term.			
10–11.	Heat Transfer or Metallurgy Met. 13.	Design M.E.11.	Applied Electricity	Heat Transfer Lecture	Mechanical Engineering Laboratory M.E.10.
11–12.	Applied Electricity E.E.5.		Strength of Materials M.E.7.	Mathematics Tutorial	
12–1.	Special Lecture	Design or Applied Thermo-dynamics Lecture		Fluid Mechanics M.E.9.	

CHEMICAL ENGINEERING

SECOND YEAR—*continued.*

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Spring Term—continued.			
2–3.	Applied Electricity E.E.5 or E.E.6.	Theory of Machines M.E.5.	—	Applied Thermo-dynamics M.33.	Metallurgy Met. 13 or Mathematics Tutorial M.33. (in second half-session)
3–4.				Fluid Mechanics Tutorial M.E.9.	Mathematics Lecture
4–5.				Mathematics M.33.	Applied Thermo-dynamics Tutorial M.E.8.
		Summer Term.			
10–11.	Applied Electricity E.E.5.	Theory of Machines M.E.5.	Applied Electricity Lecture E.E.5.	Heat Transfer Lecture M.E.30	Mechanical Engineering Laboratory M.E.10.
11–12.	Chemical Engineering Lecture		Mathematics Lecture M.33.	Heat Transfer Tutorial M.E.30	
12–1.	Special Lecture	Applied Thermo-dynamics M.E.8.	Mathematics Tutorial M.33.	Applied Thermo-dynamics Lecture M.E.8.	
2–3.	Applied Electricity E.E.5 or E.E.6.	Heat Transfer Laboratory M.E.30 or Applied Thermo-dynamics Tutorial M.E.8.	—	Heat Transfer Laboratory M.E.30 or Applied Thermo-dynamics Tutorial M.E.8.	Metallurgy Met. 13.
3–4.					Mathematics Lecture M.33.
4–5.					Mathematics Tutorial M.33.

CHEMICAL ENGINEERING

THIRD YEAR

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Autumn Term.			
10-11.	Fuel Technology Lecture Ch.E.4.	Fuel Technology Lecture Ch.E.4.	Chemical Engineering Lecture Ch.E.15.	Fuel Technology Lecture Ch.E.4.	Chemical Engineering Lecture Ch.E.15.
11.15-12.15	Chemical Engineering Drawing Office and Laboratory Ch.E.16. or Fuel Laboratory Ch.E.4.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Drawing Office and Laboratory Ch.E.16. or Fuel Laboratory Ch.E.4.
12.15-5		Chemical Engineering Drawing Office and Laboratory Ch.E.16. or Fuel Laboratory Ch.E.4.	Chemical Engineering Drawing Office and Laboratory Ch.E.16. or Fuel Laboratory Ch.E.4.	Chemical Engineering Drawing Office and Laboratory Ch.E.16. or Fuel Laboratory Ch.E.4.	
		Spring Term.			
10-11.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.
11.15-12.15	Chemical Engineering Drawing Office and Laboratory Ch.E.16.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.
12.15-5.		Chemical Engineering Drawing Office and Laboratory Ch.E.16.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.	

Tutorials are given to small groups to students daily throughout the session.

[Under revision]

CHEMICAL ENGINEERING

THIRD YEAR—*continued*

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
		Summer Term.			
10–11.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.	Industrial Explosion and Fire Hazards Ch.E.8.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Lecture Ch.E.15.
11.15–12.15	Silicate Technology Lecture Ch.E.13.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.	Chemical Engineering Lecture Ch.E.15.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.
12.15–5.	Chemical Engineering Drawing Office and Laboratory Ch.E.16.		Chemical Engineering Drawing Office and Laboratory Ch.E.16.		

DEPARTMENT OF CIVIL ENGINEERING

The laboratories of the Department of Civil Engineering provide facilities for experimental study and research in structures, fluid mechanics, soil mechanics, highway engineering, and public health engineering.

The equipment of the Main Structural Engineering Laboratory includes testing machines, and a number of test frames designed specially in the Department. Small scale suspension bridges, arch ribs, portal frames, roof truses, voussoir arches, etc., enable students to verify experimentally work done in the lectures and drawing office.

In addition, a Model-Structures Laboratory is equipped to illustrate the fundamental principles of the theory of structures and mechanical methods of stress analysis using celluloid models, sheet rubber, etc.

The Hydraulics Laboratory contains plant and structures representative of current hydraulic practice, including turbines, pumps, fans, dams, weirs, wave-tanks, cavitation and wind tunnels, nozzles, experimental pipes and valves, erosion tanks and various channels, the largest of which is 120 ft. long and 5 ft. wide, with a travelling platform The tank capacity of the laboratory is 50,000 gallons, and this provision for relatively large flows ensures that models can be studied under conditions representative of full-scale practice.

The Concrete Laboratory has the usual standard cement and concrete testing apparatus, special frames for testing comparatively large beams, and apparatus for investigating pre-stressing problems. Other equipment includes a machine designed in the Department for simulating distributed loads, and a vibrating machine.

In the Soil Mechanics Laboratory there are three triaxial compression machines, shear boxes, oedometers and a seepage tank for model tests on earth dams, etc. Special equipment includes an oedometer in which pressures up to 100 tons per sq. ft. can be supplied, a large shear box for samples 12 in. by 12 in., and a vane apparatus for measuring very low values of shear strength in clays.

The Highways Laboratory contains complete equipment for standard tests on road tars and asphaltic bitumen ; apparatus for extracting bituminous binders from asphalt or tarmacadam ; a colloid mill for making bitumen or tar emulsions ; a 50-ton hydraulic testing machine for moulding and testing bituminous mixtures and other materials ; a large testing machine for investigating the properties of bituminous jointing materials used in conjunction with concrete : equipment for the examination of aggregates, and a " rattler " testing machine for abrasive tests of road materials.

The Public Health Engineering Laboratory offers facilities for the physical and chemical analysis of water and sewage, and special apparatus enables small-scale experiments to be carried out on various water and sewage treatment processes, including aeration, coagulation, filtration, softening and sedimentation.

Organisation.

The organisation of the Department is shown in the diagram below :—

Professor and Head of the Department.—A. J. S. Pippard.

Personal Assistant.— J. E. Duncan.

Structures :
A. J. S. Pippard
S. R. Sparkes
R. J. Ashby
Miss L. Chitty
E. H. Brown
Z. S. Makowski
H. C. Cassell

Fluid Mechanics :
C. M. White
J. R. D. Francis
P. O. Wolf
D. H. Kent

Concrete Technology :
A. L. L. Baker
J. C. de C. Henderson
A. H. Mattock

Soil Mechanics :
A. W. Skempton
A. W. Bishop
D. J. Henkel

Surveying :
A. Stephenson
H. Ainsworth

Highway Engineering :
B. G. Manton

Public Health Engineering :
F. E. Bruce

Undergraduate Courses.

First Year. Courses in Engineering Drawing, Workshop. Strength of Materials, Applied Heat and Mechanism are given in the Department of Mechanical Engineering ; Mathematics and Applied Electricity in the Departments of Mathematics and Electrical Engineering respectively. In the second half-session courses in Theory of Structures and Fluid Mechanics are given in the Department of Civil Engineering.

After the examinations at the end of the session, all First Year Civil engineering students must attend the Surveying Field Course, lasting three weeks, held at some suitable place in the country.

At the end of the session students take Part I of the final examination. This consists of seven papers as follows :—

Mathematics	...	...	2 papers
Applied Mechanics	...	...	2 papers
Applied Heat	...	...	1 paper
Engineering Drawing	...	...	1 paper
Applied Electricity	...	...	1 paper

The papers in Applied Mechanics cover the subjects of Mechanism, Strength of Materials, Theory of Structures and Fluid Mechanics.

Second Year. The work in the Department of Civil Engineering consists of Theory of Structures, Fluid Mechanics and Hydraulics, and Surveying. Geology, including field work, is given by the Department of Geology and the study of Mathematics is continued. The subject of Strength of Materials is given in the Department of Mechanical Engineering.

At the end of the session students take Part II of the final examination consisting of one paper in each of the following subjects :—

Mathematics
Strength of Materials
Theory of Structures
Fluid Mechanics and Hydraulic Engineering
Surveying
Geology
Civil Engineering I
Civil Engineering II

Third Year. More advanced study of the following subjects :—

Theory of Structures
Engineering Construction
Properties of Engineering Materials
Fluid Mechanics
Soil Mechanics
Structural Design
Surveying from Air Photographs
Mathematics
Engineering Quantities

Appropriate drawing office and laboratory work form part of the year's work. Two periods of field work of four or five days each in the Autumn and Spring Terms give exercises in preliminary survey and the setting-out of works. Students may attend certain courses in addition to those specified, including one in Engineering Economics provided by the London School of Economics.

Undergraduate Syllabuses.

First Year

C.E.101. Theory of Structures.

Mr. Ashby and Mr. Brown.

Lectures and tutorials during the second half-session for all first year students of Civil, Electrical and Mechanical Engineering.

Slopes and deflexions of simply supported and encastré beams. Struts. Stress analysis of plane and space braced frames. Deflexion of a single loaded point. Strain energy. Clerk Maxwell's Reciprocal Theorem.

C.E.102. Fluid Mechanics.

Mr. Francis, Mr. Wolf and Mr. Kent.

Lectures and tutorials during second half-session for all Civil, Electrical and Mechanical Engineering students.

Properties of fluids ; pressure measurement ; pressure on submerged surfaces. Fluids in motion ; momentum problems. Conservation of energy as applied to flow problems. Viscosity. Simple problems in pipe flow.

C.E.103. Surveying Field Course.

Mr. Stephenson, Mr. Ainsworth, and other members of the staff.

Three weeks at the I.C. Field Station, Silwood Park, following Part I Examination.

First Week :—Instruction in the basic field methods of surveying.

Second and Third Weeks :—Base line measurements ; triangulation ; preliminary and location surveys for civil engineering works ; tacheometric and plane table surveys.

Second Year

C.E.201. Theory of Structures.

Professor Pippard, Dr. Sparkes, Mr. Ashby, and Mr. Brown.

A course of lectures with drawing office, laboratory and tutorial classes.

Influence Lines and Rolling Loads. Strain energy. Theorems of Clerk Maxwell and Castigliano with applications. Williot-Mohr Diagrams. Simple experimental analysis. Encastré and continuous beams. Portals and arches. Struts : Analytical and graphical treatment of laterally loaded struts. Moment distribution analysis. Theory of reinforced concrete. Suspension bridge with three-hinged stiffening girder. Analysis of masonry dams. Classical theories of earth pressure.

C.E.202. Fluid Mechanics and Hydraulic Engineering.

Professor White, Mr. Francis, Mr. Wolf and Mr. Kent.

A course of lectures with drawing office, laboratory and tutorial classes.

Streamlines and flow patterns, motion and pressures, fluid friction with engineering application of turbulence and boundary layer ideas. Problems involving gravity ; surface profiles in open channels ; wave motion. Similarity and dimensional reasoning. River and coastal erosion. Scale models. Pipe lines. Machines, including turbines, pumps, fans and propellers. Methods of measurement.

C.E.203. Surveying.

Mr. Stephenson and Mr. Ainsworth.

A course of lectures with drawing office and tutorial classes.

Methods of surveying and plotting ; Base line measurements ; triangulation ; traverses and adjustment of figures. Use and adjustment of instruments. Levelling ; contouring ; quantities ; setting-out and curve ranging. Plane-table and tacheometric surveying. Field astronomy.

C.E.204. Theory of Structures.

Mr. Ashby and Mr. Brown.

A course of lectures with drawing office and laboratory classes for non-civil engineering students.

Strain energy analysis. Williot-Mohr diagrams. Slope deflexion analysis. Continuous beams. Analysis by moment distribution. Struts ; Polar diagrams for lateral loading. Model analysis. The suspension cable. Composite structures and elementary reinforced concrete.

THIRD YEAR

C.E.301. Theory of Structures.

Professor Pippard, Dr. Sparkes, and Mr. Ashby.

Experimental analysis ; laboratory technique ; direct strain measurements ; model analysis ; introduction to photo-elasticity. Winkler theory of curved beams. Stresses in solid and braced rings. Bow girders. Applications of Williot-Mohr diagrams. The elastic cable. Suspension bridges. Voussoir arch. Advanced moment distribution analysis. Design of masonry dam profile.

C.E.302. Engineering Construction.

Mr. Manton.

Plant ; earth-moving machines, compacting machines, concrete mixers and batching plant. Time and motion studies. Cycle times. Outputs under varying conditions. Site preparation. Timbering to trenches. Design of temporary supports, e.g., arch centres and shuttering. Types of foundations. Piling, Pumps and miscellaneous equipment. Tunnelling. Brickwork.

C.E.303. Fluid Mechanics.

Professor White, Mr. Francis, and Mr. Wolf.

A course of lectures, with drawing and laboratory classes.

Applied Fluid Mechanics.

Motion and forces, flow patterns, similarity, boundary layer, turbulence, practical methods of estimating stresses. River-mechanics ; rainfall and run-off ; transport of solids ; bed forms, meander. River correction, dams, weirs, training walls, dredging.

Theory and practice of models.

Principles of water power development, irrigation, land drainage, flood control, navigation, water supply.

Hydraulic Machines.

Aerofoil-cascades, cavitation ; inlet scrolls ; suction branches, diffusers, draft tubes ; volutes.

Principal types of turbines and pumps and their limitations. Analysis of losses, part-load characteristics ; servo-mechanism, governing ; elements of lubrication and seals.

C.E.304. Soil Mechanics.

Dr. Skempton and Mr. Bishop.

A course of lectures with laboratory and drawing office classes.

Site investigation, including field identification of different soil types and sampling operations. Physical and mechanical properties of soils, classification tests, shear strength, consolidation, permeability and compaction. Stability of slopes in cuttings and embankments, coastal landslips, river banks. Principles of

the design and construction of earth dams. Earth pressure and the design of retaining walls, sheet piling and cofferdams. Bearing capacity of soils, settlement of foundations, pile driving and piled foundations. Design of road and runway foundations, compaction, stabilisation and field drainage.

C.E.305. Reinforced Concrete Design.

Mr. Henderson.

A course of lectures with drawing office classes.

Bending theory for rectangular and T beams, shear, bond. Continuous beams and slab. Use of compression reinforcement in beams. Columns concentrically loaded and columns subjected to bending moments and direct thrust by analytical and tabular approximation methods—footings. General survey of Code of Practice CP(114) 1948.

Drawing office work includes a detailed design of a simple structure and estimate. Laboratory work includes compression, aggregate grading, and beam tests.

C.E.306. Steelwork Design.

Dr. Sparkes.

A course of lectures with drawing office classes.

Estimation of and distribution of dead and live loads, and effects of wind pressure on shed and framed structures. Preparation of framing plans for shed and steel-framed structures. Design of riveted joints in trusses and lattice girders. Design of wind bracing. Design of compression members, with and without bending, and design of tension members. Design of tall building frames to resist wind pressure. Design of connexions for multi-storied framed structures. Study of the Final Report of the Steel Structures Research Committee. Design of structures having semi-rigid joints. Plastic design of steel structures.

C.E.307. Surveying from Air Photographs.

Mr. Stephenson.

Stereoscopic study and interpretation of air photographs. Air cameras and photographic procedure. Minor control, radial line and rectification methods used in drawing large scale plans. Use of the parallax bar in the determination of heights. Scope and principles of automatic stereo-plotting machines.

C.E.308. Surveying. (*For 3rd Year Mechanical Engineering students.*)

Mr. Ainsworth.

A course of lectures in the Spring and Summer terms, with one week's field work during Easter vacation.

Principles and procedure of surveying and plotting. Use and adjustment of instruments. Chain, traverse, and tacheometric surveying. Levelling, contours and sections. Earthworks, and setting-out.

C.E.309. Setting-Out of Works. (*For 3rd Year Chemical Engineering Students.*)

Mr. Ainsworth.

Use of surveying instruments in setting-out buildings from a dimensioned plan, obtaining levels on a factory site and making a simple traverse survey.

One week's fieldwork course during the previous Summer vacation and explanatory lectures.

C.E.310. Civil Engineering Quantities.

Mr. Ainsworth.

A course of about ten lectures.

Tenders and contracts. Conditions of contract and typical specifications. Units and methods of measurement, as recommended by the Institution of Civil Engineers. Bills of quantities, drafting, taking off, squaring out and abstracting.

Postgraduate Courses.

Courses of postgraduate study are available in the following :—

Structural Engineering
Concrete Technology
Hydro-Power Engineering
Hydraulic Engineering and Fluid Mechanics
Highway Engineering
Soil Mechanics
Public Health Engineering.

The courses consist of lectures, laboratory and drawing office work. Certain lectures in the Third Year Course for undergraduate students of the College are necessary for proper appreciation of postgraduate work, and postgraduate students who have graduated at other Universities will be allowed to attend these in addition to the normal postgraduate course.

Students of structural engineering and concrete technology ordinarily attend the lectures in theory of structures, reinforced concrete, soil mechanics, and pre-stressed concrete.

Students of hydro-power engineering attend courses in hydraulic structures, hydraulic machinery, fluid mechanics, applied fluid mechanics, and electrical engineering and also, if they wish, lectures in mathematics, structures, soil mechanics and reinforced concrete.

Students of hydraulic engineering and fluid mechanics and students who propose to pursue research in these fields will take selected study courses, as arranged with the Professor of Fluid Mechanics and Hydraulic Engineering.

Students of highway engineering will attend lectures in highway engineering, engineering construction (C.302), soil mechanics, geology, theory of structures, reinforced concrete, and surveying from air photographs (C.307).

The course in soil mechanics comprises lectures in soil mechanics, engineering geology, and highway engineering. Lectures in structural engineering, public health engineering, surveying from air photographs (C.307), or hydro-power engineering are optional. Special emphasis is laid on laboratory work and the design of a project. In the Easter vacation, a week or ten days will be spent in the field under the direction of a geologist.

The public health engineering course is organised in collaboration with the London School of Hygiene and Tropical Medicine. Lectures will be given in the City and Guilds College on principles of public health engineering, water supply and treatment, sewerage and sewage treatment, and the physical and chemical examination of water and sewage. Lectures in bacteriology (B.20) statistics (M.11) and introductory entomology (Z.29) will be given in the Royal College of Science. Students will attend the London School of Hygiene and Tropical Medicine for lectures in public health and local government, epidemiology, occupational health and tropical hygiene.

There are also short courses of lectures on photo-elasticity, an introduction to the mathematical theory of elasticity, and the history of civil engineering.

Short courses of lectures in special branches of mathematics such as elasticity, viscous and compressible fluids, vectors, relaxation methods, statistics, etc., are arranged by the Department of Mathematics and attendance is optional.

Facilities for research in all branches of civil engineering represented above are available for a limited number of suitably qualified students.

Syllabuses.

C.E.401. Advanced Theory of Structures.

Professor Pippard.

Stresses and displacements in rings of large diameter. The general treatment of rings and radially braced structures. Stresses and displacements of bow girders. Stresses and displacements of elastic arches. Stress problems in large pipe lines. Cross-battened girders and struts. The voussoir arch. Problems of cable-braced structures. Analysis of multi-bay and multi-storey continuous structural frameworks.

C.E.402. Reinforced Concrete Structures.

Professor Baker.

Principles of design. Buildings — Bridges — Tanks — Bins. Retaining Walls — Jetties — Wharves — Pile Groups. Raft Foundations. Practical design methods. Steel details. Plastic theory—beams. Plastic theory—frames. Plastic theory—shells. Factor of safety. Manufacture of concrete and works control. Surface finishes. Aesthetic principles. Special concretes and steels.

For drawing office work a complete project such as a Port Development Scheme is planned, including choice of site layout of jetty, wharves, warehouses, workers' flats, approaches including

bridges, etc. Students work in groups, and each individual is expected to complete full detailed working drawings of at least one important structure.

C.E.403. Prestressed Concrete.

Principles of prestressing. Fundamental method. Constructional details of various systems. General analysis for prestressed section. Selection and checking of sections. Ultimate strength of beams. Shear force and principal stresses. Deflection.

C.E.404. Reinforced Concrete Design.

Mr. J. C. de C. Henderson.

Two-way slabs, solution of elastic flat plate problem, flat slab construction, temperature stresses for flues, torsion of beams, shrinkage and creep, shuttering.

C.E.405. Solution of Statically Indeterminate Structures for Reinforced Concrete Design.

Mr. J. C. de C. Henderson.

Computational methods for solution of simultaneous equations, differentiation, and integration. The stiffness matrix G for a structure determined by influence coefficients. Methods of isolation, physical and mathematical. Prestressed continuous beams, examples, e.g. a large Vierendeel truss. Calculation of deflexions of statically indeterminate structures. Characteristic point and fixed point methods. Force-displacement relationships in matrix form.

C.E.406. Shell Roof Structure.

Mr. J. C. de C. Henderson.

Introduction to problem and history. Thin walled pipes. Use of Fourier series for the solutions. Setting up the shell equation. Geometry of strain and displacement of curved elements. Use of non-orthogonal curvilinear coordinates. Solution of shell equation to fit the boundary conditions of the edge beams and gables.

C.E.407. Mix Design and Testing.

A set of lectures coupled with laboratory work on testing of aggregates, design of concrete mixes, and the making and testing of cubes, cylinders and beams.

C.E.408. Hydraulic Structures.

Dr. Jaeger of the English Electric Co.

A course of lectures and drawing office classes.

Hydraulic Structures.

Hydrology and estimation of hydro-power ; gravity, arch and buttress dams. Intakes and sand eliminators, flood regulation. General arrangement of works. Pressure tunnels, surge tanks, pipes, anchor blocks and penstocks. Power-houses and tail-races.

Visits to Works.

A tour of modern power plants of a variety of types, in Switzerland, France and Scotland.

C.E.409. Applied Fluid Mechanics.

Dr. Jaeger of English Electric Co.

A course of lectures.

Fundamental equations for all types of surges in surge tanks and systems of surge tanks. Analytical and graphical treatment. Surge stability. Water hammer in pipe lines and systems of pipe lines. Analytical and graphical treatment. Governing of turbines.

Waves in open canals and rivers ; analytical and graphical treatment. Theory of underground power stations.

Seepage through porous media ; groundwater problems.

C.E.410. Hydraulic Turbines.

Mr. Gray of the English Electric Co.

A course of lectures and drawing office classes.

Impulse and reaction turbines, including propeller and Kaplan turbines ; history, theory, design, construction and performance.

Governors and governing ; automatic control ; speed and pressure variations.

Valves and other equipment. Power house layouts and foundations.

Model tests, similarity, cavitation. Ship tests. Acceptance tests and methods of measuring flow.

Visits to Works.

In conjunction with the lectures in the electrical department on power generation, combined visits to works to view turbines, generators and transformers in course of construction.

C.E.411. Fluid Mechanics (Complementary to C.E.408).

Prof. White, Mr. Francis and Mr. Wolf.

Courses of lectures and laboratory investigations.

Fluid Motion.

Stream-function, Navier-Stokes eqn. Similarity. Boundary layer. Secondary flows. Turbulence. Rough walls. Aerofoils in cascade. Flow under gravity, weirs, waves, tides, density-currents.

River Mechanics.

Rain, evaporation, detention ; Hydrograph. River actions. Transport of detritus. Shoals, meander. River-formulae. Flood-wave. Training methods. Influence of dams. Soil erosion. Irrigation needs. Coastal actions and protection.

Machines.

Basic theoretical principles of turbines, fans and pumps, gates and control valves.

Models.

Dimensional principles, scale effects, interpretation. Laboratory technique, pressure-models, cavitating-models, gravity-models, models with flexible walls, models with erodible beds, wave models, tidal models. Principles of laboratory and field measurements.

C.E.412. Highway Engineering.

Mr. Manton.

A course of lectures with laboratory and drawing office classes.

Ministry of Transport recommendations for the design of main and trunk roads. Modifications to suit minor roads and colonial roads. Junction design. Motorways. Traffic capacity of roads : Mathematical analyses and observed figures. Effect of intersections and other factors on capacity. Capacity of roundabouts.

Highway economics : Effect of gradients and other features. Highway materials : Tar, bitumen, concrete, various forms of asphalt and block pavings. Soil stabilisation. Road stones. Correlation of laboratory tests and service under traffic. Highway machinery : Tarmacadam and asphalt mixers. Concrete mixers. Laying and finishing machines. Drainage. Calculations of run-off.

Transition curves and super-elevation.

C.E.413. Principles of Public Health Engineering.

Mr. Bruce.

The relation between engineering and public health. The historical development of sanitation. Health aspects of water supply and sewage disposal. Stream pollution. Swimming baths. Rural sanitation problems, including small water supplies and the disposal of excreta. Housing and town-planning. Refuse disposal. The control of rodents and flies. Hygienic control of food and milk. Industrial hygiene. Tropical hygiene.

C.E.414. Water Supply and Treatment.

Mr. Bruce and Mr. Wolf.

Population estimates. Consumption of water. Sources and yields. Rainfall, run-off and river flows. The statistical analysis of records. Impoundment and collection of surface water. Groundwater collection. Storage and distribution. Principles of plumbing design.

Qualities of raw waters. Desirable standards for various purposes. Treatment processes, including aeration, sedimentation, coagulation, filtration, softening, iron removal, and disinfection. Principles of plant design.

Laboratory experiments in the treatment of water. Visits to works.

Students may also attend lectures on the Geology of Water Supply given as part of course G.43 in the Royal School of Mines, and lectures on the design and construction of earth dams given as part of course C.E.304.

C.E.415. Sewerage and Sewage Treatment.

Mr. Bruce.

Sewerage systems, separate, combined and partially separate. Quantities and variations in domestic sewage. Rainfall intensity, frequency, duration and distribution. Time-area diagrams. Hydraulics of sewers. Design principles. Storm overflows and inverted siphons. Building drainage.

The design of sewage treatment works, including racks and screens, grit chambers, sedimentation tanks, percolating filters, activated sludge systems and chemical treatment. Sludge digestion and disposal. Effluents. Stream pollution and self-purification.

Laboratory experiments in sewage treatment. Visits to works.

Facilities are available for students to acquire experience on works during the vacations. In addition, a week's visit is made to Oxford during the Easter vacation for experimental work on pilot sewage treatment plants.

C.E.416. Examination of Water and Sewage.

Mr. Bruce, Mr. Hannen and Mr. J. A. Barnard.

General principles in assessing the quality of water and sewage. Standards for raw and treated waters, sewages and effluents.

Sampling methods. Principles of limnology. The importance of algae and other organisms in water supply. Standard methods for the physical and chemical analysis of water and sewage, including practical measurement of colour, turbidity, odour, *p*H, alkalinity, hardness, chlorides, nitrogen, dissolved oxygen, bio-chemical oxygen demand and solids.

The interpretation of analyses.

A short series of lectures on chemical theory and calculations, and on elementary chemistry as applied in water and sewage treatment, is also given. Details are arranged to suit the needs of students.

C.E.417. Soil Mechanics.

Dr. Skempton, Mr. Bishop, and Mr. Henkel.

A course of lectures with laboratory and drawing office classes. The lectures are supplementary to those given under C.E.304. They include more advanced considerations of soil properties, stability analyses in relation to earth pressure, foundations and earth slopes, and the theory of consolidation ; the application of plastic theory and relaxation methods to soil mechanics problems ; and discussions concerning recent research.

In the laboratory special investigations are carried out, related as far as possible to research work in progress in the laboratory.

The drawing office classes include the design of an engineering work such as an earth dam, dock wall or sheet pile cofferdam ; together with exercises in methods of analysis.

C.E.418. Photo-Elasticity.

Mr. Brown.

A short course of lectures and demonstration of the principles and simple applications of photo-elastic methods of stress analysis.

C.E.419. Elementary Theory of Elasticity.

Miss Chitty (in collaboration with Department of Mathematics).

An introductory course of lectures for engineering students.

C.E.420. History of Civil Engineering.

Dr. Skempton.

A course of eight lectures, fully illustrated with lantern slides.

Classical Antiquity. Brief survey of civil engineering up to sixth century A.D. with special reference to Roman use of arch, cross-vault and dome.

Mediaeval. Development of the Gothic cathedral and the structural problems involved. Timber roofs. Bridges.

Renaissance. Early canal and river engineering. Masonry arch bridges. Origins of engineering science and surveying.

Industrial Revolution. Canals, docks and harbours. Use of iron in bridge and building construction.

Later 19th Century. Railways. Large span roofs and bridges. Development of steel frame buildings. Public health engineering. Introduction of modern hydraulic and structural theories, and construction techniques.

20th Century. Reinforced and prestressed concrete. Continuous structural frameworks. Roads and runways. Large dams and river basin management. Soil mechanics.

CIVIL ENGINEERING
FIRST YEAR

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
		Autumn Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Mathematics Lecture M.31.	Workshop or Eng. Laboratory M.E.2 or 6.	Materials Lecture and Tutorial M.E.3.	Applied Electricity Lecture E.E.3.
11–12.		Applied Electricity Lecture E.E.3.			Th. of Machines Lecture and Tutorial M.E.5.
12–1.	Special Lecture	Eng. Drawing Lecture M.E.1.		Mathematics Lecture M.31.	
2–5.	Engineering Drawing M.E.1.	Electrical Laboratory E.E.4.	—	Mathematics Tutorial M.31.	Eng. Drawing M.E.1.
		Spring Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Mathematics Lecture M.31.	Workshop or Eng. Laboratory M.E.2 or 6.	Materials/ Structure Lecture and Tutorial M.E.3 or C.E.101.	Applied Electricity Lecture E.E.3
11–12.		Applied Electricity Lecture E.E.3.			*Th. of Machines M.E.5 or Fluid Mechanics C.E.102. Lecture and Tutorial
12–1.	Special Lecture	Eng. Drawing Lecture M.E.1.		Mathematics Lecture M.31.	
2–5.	Engineering Drawing M.E.1.	Electrical Laboratory E.E.4.	—	Mathematics Tutorial M.31.	Th. of Machines (D.O.) M.E.5.
		Summer Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Mathematics Lecture M.31.	Workshop or Eng. Laboratory M.E.2 or 6	Structures Lecture and Tutorial C.E.101.	Applied Elect. Lecture E.E.3.
11–12.		Applied Elect. Lecture E.E.3.			Fluid Mechanics Lecture and Tutorial C.E.102.
12–1.	Special Lecture	Eng. Drawing Lecture M.E.1.		Mathematics Lecture M.31.	
2–5.	Engineering Drawing M.E.1.	Electrical Laboratory E.E.4.	—	Mathematics Tutorial M.31.	Th. of Machines (D.O.) M.E.5.

* M.E.5 in first Half-Session. C.E.102 in second Half-Session.

CIVIL ENGINEERING
SECOND YEAR

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
		Autumn Term.			
10–11.	Mechanical Laboratory M.E.20 or Tutorial	Hydraulics Lecture C.E.202.	Strength of Materials Lecture and Tutorial	Hydraulics Lecture C.E.202.	Mathematics Lecture and Tutorial M.33.
11–12.		Surveying Lecture C.E.203.		Surveying Lecture C.E.203.	
12–1.		Structures Lecture C.E.201.	Mathematics Lecture M.33.	Structures Lecture C.E.201.	Geology Lecture G.40.
2–5.	Hydraulics C.E.202.	Geology Laboratory G.41.	—	Surveying C.E.203.	Structures C.E.201.
		Spring Term.			
10–11.	Mechanical Laboratory M.E.20 or Tutorial	Hydraulics Lecture C.E.202.	Strength of Materials Lecture and Tutorial	Hydraulics Lecture C.E.202.	Mathematics Lecture and Tutorial M.33.
11–12.		Surveying Lecture C.E.203.		Surveying Lecture C.E.203.	
12–1.		Structures Lecture C.E.201.	Mathematics Lecture M.33.	Structures Lecture C.E.201.	Geology Lecture G.40.
2-5.	Hydraulics C.E.202.	Geology Laboratory G.41.	—	Surveying C.E.203.	Structures C.E.201.
		Summer Term.			
10–11.	Tutorial	Hydraulics Lecture C.E.202.	Strength of Materials Lecture and Tutorial	Hydraulics Lecture C.E.202.	Mathematics Lecture and Tutorial M.33.
11–12.		Surveying Lecture C.E.203.		Surveying Lecture C.E.203.	
12–1.		Structures Lecture C.E.201.	Mathematics Lecture M.33.	Structures Lecture C.E.201.	Geology Lecture G.43.
2–5.	Hydraulics C.E.202.	Geology Laboratory G.41.	—	Surveying C.E.203.	Structures C.E.201.

Note.—The Third Year Time-table will be published at the beginning of the Session and displayed on the Notice Boards.

DEPARTMENT OF ELECTRICAL ENGINEERING

In the Electrical Engineering Department the laboratories comprise those for Measurements, Communications and Electronics, and Machinery and Power.

The Measurements Laboratories are equipped for the measurement of inductance, capacitance and resistance at power, audio and radio frequencies ; for investigating the properties of magnetic, dielectric and semi-conducting materials ; for instrument and meter calibrations and for photometric measurements. A wide range of standard apparatus is available for these purposes, and in particular the photometric section contains a cube photometer, a precision radial photometer and a direct reading photo-electric radial photometer.

The Communications and Electronics Laboratories contain a representative range of modern audio and radio frequency instruments and apparatus on which systematic experiments are conducted, experimental artificial lines, valve amplifiers and oscillators, and oscillographs and a large store of component parts and instruments which can be assembled by the students as required in their more advanced experiments. Magnetron and Klystron oscillators generating frequencies of the order of 10^{10} cycles per sec. are employed for studies on waveguides and simple aerial systems. High vacuum pumping plant is available for use in investigations on experimental thermionic valves and cathode ray tubes, and acoustic measurements are carried out in a laboratory containing a 9 ft. cube with absorbing walls and two sound proof reverberation chambers, each of volume about 4,000 cu. ft.

The Electrical Machines Laboratories contain a large number of direct current motors and generators, single and polyphase alternating current motors, generators and transformers. rotary converters, motor generators, and mercury arc and copper oxide rectifiers. Special fittings and devices are incorporated in this plant whereby the underlying electric and magnetic principles can be thoroughly investigated by different methods under all operating conditions. There is also a special demonstration motor-alternator set comprising a direct-current compound wound motor fitted with slip-rings for a.c. supply, a three-phase, 50 cycle, sine-wave alternator and two auxiliary three-phase sine-wave alternators of 150 and 250 cycles ; voltage wave-forms containing third and fifth harmonics at varying phase angles can therefore be obtained. Search coils are fitted on the motor and main alternator to enable magnetic investigations to be made.

The equipment of the Electrical Power Laboratories includes an artificial transmission system electrically equivalent to 100 miles at 132,000 volts, a short-circuit calculator, a single line arranged for fault testing and localisation, an oil immersed three-phase condenser for power factor improvement and a selection of modern switch gear, control and protective apparatus, including complete contactor panels with push-button control. In the high-voltage testing laboratory the installation comprises two 40,000 volt and one 50,000 volt testing transformers fitted with calibrated spark gap and suitable controls, a high-voltage cathode ray oscillograph complete with high-speed time base suitable for recording non-repeating transient phenomena, a surge

generator equipment for the investigation of Lichtenberg figures, a selection of modern pin and suspension type insulators and insulating materials.

Several of the laboratories referred to above are used for the accommodation of research, as well as undergraduate students, but additional laboratories are available exclusively for post-graduate course and research work and are specially equipped for this purpose.

Undergraduate Courses.

First-year students take courses in Strength of Materials, Applied Heat, Hydraulics, Mechanisms and Engineering Drawing in the Mechanical Engineering Department ; in Applied Electricity in the Electrical Engineering Department and in Mathematics in the Mathematics Department. These courses are common to all first-year Civil, Electrical and Mechanical Engineering students. In addition Electrical students attend an introductory course of lectures on Atomic Physics.

Second-year students take courses in Strength of Materials and Vibrations and in Mechanisms and Thermodynamics (including Heat Transmission) in the Mechanical Engineering Department ; in Electrical Theory and Measurements, Electrical Machines and Power, Electronics and Electrical Communications in the Electrical Engineering Department ; and in Mathematics.

All *Third-year students* are required to attend courses in Advanced Electric Circuit and Field Theory, Advanced Electrical Measurements, the Properties of Electrical Engineering Materials (including magnetic, dielectric, semi-conducting and electron-emitting materials), and Metallurgy. In addition they take advanced courses of lectures and laboratory work in *one or other* of the two main branches of electrical engineering, Electrical Machines and Power or Electronics and Electrical Communications. In connection with the latter they are required to prepare a report dealing with a particular aspect of analytical or experimental work on which they have concentrated towards the end of the session.

The courses referred to in the preceding paragraph leave scope for students to attend on an optional and self-selected basis a limited number of the advanced courses provided by the Mathematics, Physics and Mechanical Engineering Departments. Alternatively arrangements may be made for a student to spend a portion of his time at the London School of Economics. The purpose of this aspect of the course is to enable students to extend their knowledge of any non-electrical subjects in which they may have developed a special interest.

First Year—Part I

E.E.1. Applied Electricity.

Prof. Willis Jackson, Mr. Humphrey Davies and Mr. Rutenberg.

A course of lectures and tutorial work on the principles of Electricity and Magnetism as applied to Electrical Engineering.

Syllabus.—The basic laws of magnetism and electricity and their application to the calculation of capacitance, self and

mutual inductance, the force on current carrying conductors and induced electromotive force. The analysis of magnetic and electric circuits. Alternating current circuit theory. Direct and alternating current measuring instruments. Thermionic valves and the cathode ray oscillograph, and simple associated circuits. D.C. and A.C. generators and motors ; construction and principles of operation. The single phase transformer.

E.E.2. Electrical Machines and Electrical Measurements Laboratories.

A laboratory course for students taking the Lecture and Tutorial Course E.E.1.

Syllabus.—Measurement of resistance. Properties and calibration of instruments and meters. Laws of the magnetic circuit ; magnetic properties of iron. Simple properties and tests of alternating current and direct current generators and motors ; and of transformers. Insulation testing. Photometrical measurements ; comparison of sources ; measurements of intensity of illumination.

E.E.3. Applied Electricity.

Mr. Hopkin and Mr. Kayser.

A course of lectures and tutorial work in Electrical Engineering for First Year Civil and Mechanical Engineering students.

Syllabus.—As for E.E.1.

E.E.4. Electrical Machines and Electrical Measurements Laboratories.

A laboratory course for students taking the lecture and tutorial course E.E.3.

The syllabus is the same as for E.E.2, as much of the work being done as the available time permits.

E.E.5. Electrical Engineering.

Mr. Hopkin and Dr. Westcott.

A course of lectures and tutorial work in Electrical Engineering for second year Chemical Engineering students.

Syllabus.—As for E.E.1.

E.E.6. Electrical Machines and Electrical Measurements Laboratories.

A laboratory course for students taking the lecture and tutorial course E.E.5.

The syllabus is the same as for E.E.2, as much of the work being done as the available time permits.

E.E.7. Applied Electricity.

Mr. Park.

A course of lectures and tutorial work on the applications of Electricity for second-year students of the Royal School of Mines.

Syllabus.—The Engineering aspects of the fundamental laws of electricity and magnetism. Simple alternating current

theory. Single-phase power and power factor. The three-phase circuit, including simple calculations of star and delta connections. Processes of rectification. The general principles, construction and operation of alternating and direct-current machines and transformers. The construction and principles of electrical measuring instruments. Electrical transmission and distribution systems.

E.E.8. Electrical Machines and Electrical Measurements Laboratories.

A laboratory course for students of the Royal School of Mines taking the lecture and tutorial course E.E.7.

The syllabus is similar to that of E.E.2, as much of the work being done as the available time permits.

Second Year—Part II

(Electrical Engineering Students.)

E.E.11. Electrical Theory and Measurements.

Mr. Urwin.

A course of lectures and tutorial classes, throughout the whole session, dealing with :—

Symbolic notation method of A.C. circuit analysis. Complex wave forms. Electric network theorems. Analysis of circuits with distributed constants. Electrical measurements and measuring instruments. Electro-magnetic and cathode ray oscillographs.

E.E.12. Electrical Machines.

Mr. Adkins.

A course of lectures and tutorial classes, throughout the whole session, on the principles, construction and operation of the following :—

A.C. Synchronous machines. Transformers. Induction motors. D.C. machines. Rotary converters. Mercury arc rectifiers and A.C. commutator motors.

E.E.13. Electrical Machines and Electrical Power—Drawing Office.

Mr. Adkins and Mr. Hopkin.

A course of lectures and drawing office work in the fundamental principles underlying the design of electrical machines and electrical power systems, with examples from modern practice.

E.E.14. Electrical Power.

Mr. Humphrey Davies.

A course of lectures and tutorial classes, throughout the whole session, dealing with :—

Modern methods of generating and distributing electrical energy. Comparison of A.C. and D.C. systems of distribution. Solution of network problems. Systems of transmission. Transmission line calculations. Cables for low, medium and

high voltages. Surges and protection against surges. Switch gear, methods of arc control. Busbar arrangements. Principles of protection. Fault calculation. Power supply economics and tariffs.

E.E.15. Electronics.

Prof. Willis Jackson and Dr. Lamb.

A course of lectures and tutorial classes, during the first half-session, dealing with :—

Electronic structure of matter. Basic distinctions between conductors, semi-conductors and dielectric materials. Production of free electrons—thermionic, photoelectric, secondary. Electron ballistics. Valve characteristics, valve operation, voltage and power amplifiers. Motion of charged particles through gases. The gas-filled diode and triode. Breakdown of gases. Contact rectification.

E.E.16. Electrical Communications.

Mr. Tombs.

A course of lectures and tutorial classes, during the second half-session, dealing with :—

Systems of electrical communication, and the general principles involved in line and radio telegraphy and telephony, and in television. Apparatus for handling signals. Valve operation in the linear and non-linear region. Line and radio transmission. Noise in communication systems.

E.E.17. Electrical Communications—Drawing Office.

Mr. Urwin and Mr. Tombs.

A course of drawing office instruction in graphical methods of dealing with telephone line problems and circuit diagrams in telegraphy and telephony.

(For students registered under Old Regulations, supplementary lecture courses will be available in Electrical Machines and Electrical Power, E.E.18 and in Electrical Communications and Electronics, E.E.19.)

Second Year—Part II

(Laboratory Courses.)

E.E.20. Measurements Laboratory.

The calibration of direct current and alternating current instruments. The comparison of resistances and measurement of temperature co-efficient by precision methods. The Kelvin Double Bridge. Alternating Current Bridges. The vibration galvanometer. The electrostatic and dynamometer wattmeter. Losses on iron under alternating magnetisation. Instrument transformer testing. Measurement of losses in lines and cables. Measurements depending upon the use of thermionic valves. Photometry and photo-electric cells.

E.E.21. Telecommunications and Electronics Laboratory.

Distribution of voltages and currents along a leaky telegraph line and telephone line ; arrival curve with submarines cables.

Tests on telephone instruments and circuits, e.g. the microphone, the receiver, telephone transformer and relays, telephone repeaters and loaded line.

The valve amplifier, oscillator and rectifier. High frequency experiments ; resonance curves. The wavemeter and measurement of resistance, capacitance and inductance at radio frequencies.

E.E.22. Electrical Machines and Power Laboratory.

The laboratory is equipped with different types of electrical machines, transformers, artificial transmission lines, high voltage apparatus, contactors, circuit breakers and other apparatus such as rectifiers, oscillographs, etc. Students perform experiments on all these different types to determine their characteristics, operation and control under different conditions and to confirm the theory of action.

Second Year—Part II

(Mechanical Engineering Students.)

E.E.23. Electrical Engineering.

Mr. Hopkin and Mr. Urwin.

A course of lectures and tutorial classes, during the autumn and spring terms, for Mechanical Engineering students.

General outline of modern systems of electrical power distribution. Characteristics of D.C. and A.C. motors. Starting and speed control equipment. Supply tariffs. Economics of power factor improvement. Electronics, elementary theory of the diode and triode, valve characteristics and operation as rectifiers, amplifiers and oscillators. Practical applications of electronic devices for measurements and control.

E.E.24. Electrical Engineering—Laboratory.

A course of laboratory work, during the first half-session, in the Electrical Machines and Power Laboratory and in the Electronics Laboratory, for students taking the lecture course E.E.23.

Third Year—Part III

(Electrical Engineering Students.)

E.E.25. Advanced Electric Circuit and Field Theory.

Dr. Cherry.

Use of determinants in the formulation and solution of multi-mesh linear circuit equations. Principle of duality. Driving point- and transfer-impedances. Circuit classification : linear, non-linear ; unilateral, bi-lateral ; lumped, distributed. Transient behaviour ; the classical method. Impedance functions. Complex-frequency and the operatior ρ. Natural modes.

Foster's reactance theorem. Four-terminal network theory; equivalent-τ and -π. Fourier integral analysis; physical properties of networks. Cascaded networks; attenuators. Zobel wave-filter theory. Derived types. Circuit theory as a "finite-difference" aspect of electro-magnetic theory.

E.E.26. Advanced Electrical Measurements.

Mr. Urwin.

Extension of course E.E.11.

E.E.27. Properties of Electrical Engineering Materials, including Metallurgy.

Prof. Willis Jackson and Prof. Dannatt.

A review of the structure, properties and spheres of application of available insulating, semi-conducting, magnetic and electron-emitting materials, and of the ferrous and non-ferrous materials employed in electrical construction.

E.E.28. Advanced Study of Electrical Machines and Power.

Mr. Adkins, Mr. Humphrey Davies, Mr. Prigmore, Dr. Westcott, and Mr. Slemon.

More advanced treatment of certain items of courses E.E.12 and 14. Additionally lecture courses dealing with high voltage phenomena, the principles and methods of power system analysis, electronic control of machines, and electric traction, from which students may make a selection, will be provided.

or

E.E.29. Advanced Study of Electronics and Electrical Communications.

Prof. Willis Jackson, Dr. Gabor, Mr. Tombs, Dr. Lamb, Dr. Boothroyd and Mr. Brown.

More advanced treatment of certain items of courses E.E.15 and 16. Additionally lecture courses dealing with high vacuum phenomena, ultra high frequency transmission lines and wave-guides, radio-wave propagation phenomena and electro-acoustics, from which students may make a selection, will be provided.

Students will be required to attend a course in Mathematics for part or the whole of the session. They will also have the opportunity of attending optionally a limited number of special courses provided in the Physics and Mechanical Engineering Departments and in the London School of Economics.

During the autumn term the laboratory work will be related directly to the subject matter of the above-mentioned lecture courses, but during the spring and summer terms students will undertake a special laboratory investigation on which they will be required to present a full report at the end of the session, and address a student colloquium.

Second Year—Mining Students

E.E.30. Electrical Engineering.

Mr. Park.

A course of lectures, tutorial work and laboratory work in Electrical Engineering for Second Year Mining Students during the second half-session.

Syllabus.—Characteristics and operation of alternators, synchronous motors and induction motors. Parallel operation, methods of starting. Mining type transformers. Characteristics and operation of d.c. shunt, series and compounds motors. Methods of starting and speed control. Principles involved in the use of electricity for winding, haulage, ventilation and pumping. Construction, laying and jointing of mining cables above and below ground. Trailing cables. Problems in connection with the transmission and distribution of electrical energy for mines, including power factor improvement.

Postgraduate Courses.

Postgraduate courses leading to the Diploma of Imperial College are provided in the fields of "Electronics and Communications" and of "Electrical Machines and Power". An outline of the scope of these courses is given below.

Within the Electronics and Communications course, students may concentrate to a substantial extent in the second and third terms on one or other of the three main branches catered for, namely, Electric Circuit Theory, Physical Electronics, or Micro-wave Systems and Wave Propagation. Alternative courses in Mathematics will be available to suit the previous mathematical attainment of individual students.

The Electrical Machines and Power course will consist of courses in Mathematics, and Electric Circuit Theory, combined with a selection from more specialised courses on Electrical Machines, Power System Analysis, Dielectric Phenomena, and High Voltage Measurements.

Some of the lecturers are drawn from industrial concerns and Government Establishments and visits to these and other organisations are arranged from time to time with a view to assisting students to gain an appreciation of the industrial significance of their studies.

Tutorial classes are associated with most of the lecture courses detailed below, and are devoted to the application of the subject matter to the solution of appropriate problems. Where possible, the latter are closely integrated with the laboratory work.

During the autumn term the laboratory work occupying three days per week will be of a general character, as a preliminary to the pursuit during the Lent and Summer terms of an independent investigation falling within the selected special branch of study. Students will be required to address a colloquium on this work and to prepare a dissertation concerning it. As far as practicable the subjects of investigation will be chosen so that they lead to an extended programme

of research for those who wish, and are found suitable, to remain in the department for a longer period as candidates for the M.Sc. or Ph.D. degrees.

The courses are intended to cater for graduates in Physics and Mathematics, as well as in Electrical Engineering. Applications for postgraduate places are normally considered during the first week of May ; candidates are therefore advised to apply to the Professor not later than May 1st.

Fuller information about the lecture courses outlined below, and such others as are likely to be made available, will be supplied on request.

Electrical Communications and Electronics.

E.E.31. Linear Electric Circuit Theory.

Dr. Cherry.

Historical development of circuit theory. Topological and energy aspects of a network. Matrix representation. Network duality. Communication networks. The use of determinants and matrices and network transformations. Conjugate A.C. vectors. Transient waves—Fourier Integrals and Transforms. Steady state method of network response calculation. The idea of "complex frequency". Poles and zeros and natural modes. Foster's reactance theorem. Laplace transforms. Cauchy's integral and the meaning of residues. Heaviside's expansion theorem. Network characteristics and problems of synthesis. Minimum phase networks. Conformal transformations —low pass/band-pass case. The exponential transformation. Wave-filter design.

E.E.32. Application of the Methods of Classical Dynamics to Lumped Electric Circuits.

Dr. Cherry.

The foundation of the principal circuit theorems as follows :— Concept of action in a reactive circuit. Hamilton's Principle applied to reactive circuits. Langrangian dynamics and equations of motion. Conservative and dissipative systems. Linear and non-linear circuits—Time-varient parameters. Electro-mechanical systems. Hamiltonian dynamics. Foster's Reactance Theorem. Theory of normal co-ordinates ; natural modes.

E.E.33. Theory of Linear Closed-Loop Control Systems.

Dr. Westcott.

Feedback in single-loop systems ; the simplification leading to Black's formula and its applicability to servo-mechanisms.

Survey of standard methods of analysis. The generalisation of Nyquist's criterion ; Leonard's criterion.

Transient response by graphical method ; the limiting step-response.

Introduction to statistical analysis of signals. The minimum mean square criterion in following and development of standard forms. An example, including an assessment of power requirements.

Conclusions.

E.E.34. Non-Linear Electronic Systems.

Dr. Boothroyd.

Linear wave shaping. Differentiating and integrating circuits. Normalised circuit characteristics. Uses of delay lines.

Current and voltage valve generators. Impedance level and interaction of adjacent circuits. Feedback. Cathode follower. Miller and other integrators.

Non-linear oscillators. Astable, nonstable and bistable states. Eccles-Jordan circuit. Forms of multivibration. Transitron and Phantastron circuits.

Limiting D.C. restoratron. Use of diodes as switches and limiters. Other forms of limiters. Amplitude comparators and selectors.

Phase-shifting circuits and devices. Magslips. Time scale division. Delay measurement. Gating. Applicatings of delay lines.

Fast frequency generation. Limiting response of amplifiers. L.F. and H.F. correction. Capacity limitation of gain x bandwidth product. Response of successive stages. Examples of Fourier Transforms.

E.E.35. Theory and Design of Wave Filters.

Dr. Boothroyd.

General introduction on filtering, and approaches to design. Principles of image parameter filter design ; image attenuation, image impedance. Zobel filters : performance when image impedance terminated, and when terminated in fixed resistances as in practice. Design of such filters for given insertion loss performance ; graphical methods. Lattice filters ; reactance arm properties ; choice of design parameters ; performance ; equivalent ladder networks ; crystal filters. Insertion loss theory of filter design (the network synthesis approach to design) : introduction to Darlington's method. Circumstances under which marked advantages are gained over image parameter methods.

E.E.36. The Electromagnetic Field.

Dr. Gabor.

Vector algebra and analysis. The theorems of Gauss and Stokes. Green's theorem. Units and dimensions—M.K.S. system. Electrostatic Fields. Formal and physical theory of dielectrics. Magnetostatic fields. Physical theories of ferromagnetism.

The electro-magnetic equations—Maxwell's equations. Solution of Maxwell's equations by electromagnetic potentials and by Hertzian vector. Radiation of a Hertzian dipole.

E.E.37. Electromagnetic Wave Diffraction Phenomena.

Dr. Clemow.

Discussion of classical diffraction theory : Huygin's Principle, Fresnel zones, Babinet's Principle, Kirchhoff's formulation. Application of plane wave spectra and Fourier analysis technique to " black " screen diffraction problems. Sommerfeld's solution for the perfectly conducting half-plane. Range of problems with perfect conductors and involving media or material of finite conductivity.

E.E.38. Introduction to Internal Electronics.

Dr. Gabor.

Solution of the electrostatic field under given charge and boundary conditions. Green's function. Conformal and logarithmic transformation. Inversion in three dimensions. Electron motion in an electrostatic field. Deflecting condensers. The momentum integral. Electron sorting by a cylindrical wire. Electron motion in a magnetic field. The Larmor rotation. Magnetic prism spectographs. Electron streams—diodes and triodes. Pierce guns. The Boyle-Charles law and Maxwell-Boltzmann distribution.

E.E.39. Electron Dynamics. (Treated as an aspect of General Dynamics.)

Dr. Gabor.

Treatment of dynamical phenomena by the methods of Lagrange and Hamilton. Kinetic and potential energy in mechanical systems. Degrees of freedom.

Electric and magnetic energy in electromagnetic field. Poynting's theorem. The Lagrangian method in electron dynamics. Hamiltonian dynamics. The canonical equations. Lagrange's invariant. The Hamilton-Jacobi equation. Lionville's invariant. Applications to typical electronic problems—the electron microscope ; particle accelerators ; microwave valves.

E.E.40. Theory of Microwave Systems.

Prof. Willis Jackson and Mr. Brown.

Maxwell's equations. Plane wave propagation. Skin effect. H.F. transmission lines ; formulae and measurements. Rectangular and circular waveguide propagation. Boundary conditions and wave impedance. Poynting vector and waveguide attenuation. Evanescent modes—" piston " attenuator. Cavity Resonators and their applications. Microwave radiators—characteristics of various types.

E.E.41. Sources of Microwave Power.

Discussion of the principle of operation, design features and performance of short wave triodes, the Klystron, the Magnetron and the Travelling Wave tube.

E.E.42. Radio Wave Propagation Phenomena.

Dr. Saxton.

Radiation from simple aerials : free space radiation wave polarisation. Wave propagation over a plane earth. Diffraction round a spherical earth. Ground-wave field intensity. Characteristics of the ionosphere. Most suitable frequencies for long distance communication. Weather effects on propagation : abnormal refraction : absorption and scattering in the atmosphere.

E.E.43. Radio Antennae Systems.

Mr. Page.

Discussion of the constructional, impedance and radiation characteristics of medium, short and microwave antenna systems.

E.E.44. Semi-conductors, with particular reference to the Transistor.

Prof. Willis Jackson and Dr. Boothroyd.

Discussion of the distinctions between conductors, semiconductors and insulators in terms of the electronic structure of solids, leading to particular consideration of the conductor processes in Germanium and the mechanism of behaviour of contact and junction type transistors.

Treatment of the transistor as a circuit element and discussion of its spheres of application.

E.E.45. Theory of the Communication of Information.

Dr. Cherry.

A treatment of various theories of communication, with their inter-relations. " Information " ; its various meanings ; symbolism, language and codes. Language statistics ; redundancy. Hartley and Gabor theories ; " structural information ". Uncertainty. Quantisation. Bandwidth, time, noise, signal power relations. " Selective information " as $H = \sum P_i \log P_i$. Comparison to Boltzmann's entropy. Information compression and maximising Shannon's general results ; noise and lost information. Channel capacity. Discussion of the entropy concept and its restricted use.

A generalization of the subject ; application to other sciences.

Electrical Machines and Power.

E.E.46. Transients in Electrical Power Networks.

Mr. Humphrey Davies and Mr. Slemon.

Transients in coupled circuits with lumped and distributed constants. Application of matrix algebra to differential equations of power networks. Principles of control systems.

E.E.47. Electrical Power Networks.

Mr. Humphrey Davies and Mr. Slemon.

Solution of networks by reduction and systematic computation. Formulation of steady-state equations. Use of matrices and of the method of symmetrical components in calculating the effect of single and double faults. Equations for load studies. Equivalent circuits for lines, cables, transformers and synchronous machines.

E.E.48. Power System Performance (Transient Phenomena).

Dr. Mortlock.

Overvoltages due to lightning and methods of limitation. Methods of circuit interruption ; restriking voltage ; single-pole and triple-pole reclosing. Effects of unbalanced impedances ; neutral inversion. Impulse-voltage characteristics of insulators, transformers, etc. ; impulse testing. Co-ordination of insulation and surge limitation. Effect of arc-furnaces, etc., on system voltage.

E.E.49. Analysis of Rotating Electrical Machines.

Mr. Adkins.

General equations for an ideal two-pole machine in terms of the self and mutual impedances of the windings, using a two-axis method. Application to steady-state and transient conditions in D.C. machines and in synchronous induction and commutator A.C. machines. Use of matrices for the manipulation and transformation of equations. General theory based on Kron's generalised electrical machine.

E.E.50. Dielectric Phenomena.

Prof. Willis Jackson.

Discussion of the mechanisms of dielectric loss and dielectric breakdown and of recent developments in insulating materials for power system applications.

E.E.51. High-Voltage Measurements.

Mr. Slemon.

Special problems connected with the generation and measurement of high voltages and currents in a research laboratory.

Research.

Considerable laboratory facilities are available on the Measurements, Machines, Power, Electronics and Communication sides of Electrical Engineering for those wishing to conduct research leading to higher degrees of the Univerity. Graduates of the department and others who have proved themselves specially suited to research work may be accepted as research students without being required to complete first a postgraduate course of the form referred to above. Such students are not obliged to attend any lecture courses, though they may be advised to do so. Candidates for higher Degrees of the University are also eligible for the Diploma of the Imperial College.

Applications for acceptance as a research student should desirably reach the Professor not later than 1st May.

Nuclear Reactors.

A special course of lectures on Nuclear Reactors will be given on Friday afternoons at 4.30 p.m. throughout the Session. The lectures are to be given by members of the staff of the Atomic Energy Research Establishment, Harwell.

(*continued on page* 149.)

ELECTRICAL ENGINEERING
FIRST YEAR

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Autumn Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Electrical Laboratory E.E.2.	Mathematics Lecture M.31.	Materials Lecture and Tutorial M.E.3.	Applied Elect. Lecture E.E.1.
11–12.			Applied Elect. Lecture E.E.1.		Mechanism Lecture and Tutorial M.E.5.
12–1.	Special Lecture		Engineering Drawing Lecture M.E.1.	Mathematics Lecture M.31.	
2–5.	Mathematics Tutorial M.31.	Engineering Drawing M.E.1.	—	Workshop M.E.2. or Mechanical Engineering Laboratory M.E.6.	Engineering Drawing M.E.1.
		Spring Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Electrical Laboratory E.E.2.	Mathematics Lecture M.31.	Materials/ Structures Lecture and Tutorial M.E.3. or C.E.101.	Applied Electricity Lecture E.E.1.
11–12.			Applied Elect. Lecture E.E.1.	Mathematics Lecture M.31.	Theory of Machines/ Fluid Mechanics Lecture and Tutorial M.E.5. or C.E.102.
12–1.	Special Lecture		Engineering Drawing Lecture M.E.1.		
2–5.	Mathematics Tutorial M.31.	Engineering Drawing M.E.1.	—	Workshop M.E.2. or Mechanical Engineering Laboratory M.E.6.	Theory of Machines (D.O.) M.E.5.
		Summer Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Electrical Laboratory E.E.2.	Mathematics Lecture M.31.	Structures Lecture and Tutorial C.E.101.	Applied Electricity Lecture E.E.1.
11–12.			Applied Electricity Lecture E.E.1.		Fluid Mechanics Lecture and Tutorial C.E.102.
12–1.	Special Lecture		Engineering Drawing Lecture M.E.1.	Mathematics Lecture M.31.	
2–5.	Mathematics Tutorial M.31.	Engineering Drawing M.E.1.	—	Workshop M.E.2. or Mechanical Engineering Laboratory M.E.6.	Theory of Machines (D.O.) M.E.5.

ELECTRICAL ENGINEERING
SECOND YEAR

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Electronics Lecture E.E.15.	Electrical Power Lecture E.E.12.	Strength of Materials Lecture and Tutorial M.E.13.	Electrical Machines Lecture E.E.14.	Electrical Laboratory E.E.20, 21, 22.
11–12.		—			
12–1.	Electrical Communications Lecture E.E.16.	Mechanical Engineering Lecture M.E.21.	Mathematics Lecture M.33.	Electrical Theory and Measurements Lecture E.E.11.	
2–4.	Drawing Office E.E.13, 17.	Mechanical Engineering Laboratory M.E.23 or Design M.E.22.	—	Mathematics Lecture and Tutorial M.33.	Electrical Laboratory E.E.20, 21, 22.
4-5.				—	

Note.—The third year time-table will be available at the beginning of the Session.

Nuclear Reactors (*continued*).

The course will be divided into three groups of lectures as follows :

The first group of twelve will be concerned with slow neutron natural uranium reactors, concluding with a detailed description of the large pile at Harwell. The second group of six lectures will deal with particular aspects of reactors of various types with discussion of the scientific and engineering problems involved. The third group will consist of three specialised sections dealing respectively with slow and fast neutron theory, heat transfer and reactor design, and the experimental use of a reactor. It is hoped to conclude the course with a visit to Harwell.

Further particulars may be obtained from the Deputy Registrar, City & Guilds College.

DEPARTMENT OF MECHANICAL ENGINEERING

The aims of the Department are two-fold, firstly to give a broad general training for those who wish to enter engineering industry with no particular specialization or to take up specialized study later, and secondly to give in the latter part of the course instruction in the more specialized branches of mechanical engineering science.

In order to meet the requirements of the new undergraduate courses, to overtake the arrears of development due to the war, and to provide additional facilities for postgraduate research, the laboratories are being extensively re-arranged and modernized. A large area of the floor of the Goldsmiths' Laboratory has been removed so as to afford natural lighting to the extensive basement which is being developed for research, and a gallery of 800 square feet has been constructed to accommodate apparatus for the study of fluid flow and air measurements. A new internal combustion engine test bay has also been developed.

The equipment in the laboratories includes the following :—

Undergraduate Laboratory Course.

Steam Plant.

The Boiler Room contains one water-tube and two Lancashire boilers and an oil-fired superheater. The plant is equipped with all necessary measuring gear, CO_2 recorders, steam meter and pyrometers so that students can carry out comprehensive trials. The boilers supply steam to the laboratories for running the various steam engines including simple and compound engines, a 100 h.p. Sulzer Unaflow engine operating on superheated steam, and a 100 h.p. two-stage velocity-compound impulse turbine.

Internal Combustion Engines.

Installed in the laboratories are gas engines operating on town and producer gas and a complete range of compression-ignition oil engines exemplifying the various systems of fuel injection including blast, ante-chamber, separate combustion chamber, and direct injection ; there is a National gas/oil engine of advanced design. Recent additions are a Ricardo E.6 variable-compression engine fitted with a Farnborough indicator, specially adapted for the study of the characteristics and rating of light liquid fuels, and a single-cylinder, high-speed, direct-injection oil engine developing 16 h.p. at 1,600 r.p.m. for investigations of the performance of heavy fuel oils. The Ricardo engine is also provided with an alternative cylinder head with Comet combustion chamber enabling it to be run as a compression-ignition engine. A specially designed test bench for the study of the performance of fuel injection pumps and the problems arising in connection with solid-injection fuel systems is about to be installed.

Electronic Equipment.

In connection with the experimental work on internal combustion engines, two cathode-ray oscillographs are provided, one

being a mobile unit which, in addition to its use as an engine indicator, can be adapted for experimental work on vibrations and also as a recorder for strain gauges.

Refrigeration.

A CO_2 vapour-compression machine is arranged so that students can carry out complete performance tests. A "Frigidaire," presented by the makers, is adapted for the cooling of air and enables the problems of air-conditioning to be studied. The laboratory also has a small domestic type dual-vapour machine.

Testing of Materials.

For experiments on strength of materials, there are a number of universal testing machines of capacities ranging from 100 tons to 5 tons, some mechanically and some hydraulically operated either from the hydraulic mains or from an accumulator. Recently installed is a 50-ton machine of the latest design operated from a self-contained motor-driven pump. The fatigue-testing equipment comprises a 6-ton Haig machine and a Robertson-Haig wire tester. There are also special machines for torsion, hardness and impact testing. A small laboratory, complete with dark room, is equipped for the heat treatment of test pieces.

Other apparatus includes calorimeters for the determination of the calorific value of solid, liquid and gaseous fuels, stroboscope equipment, and all necessary extensometers, travelling microscopes and other measuring apparatus.

Postgraduate Research

There are facilities for research in all branches of Mechanical Engineering, more particularly in gas dynamics and heat transfer, and properties of materials.

The basement area of the Goldsmiths' laboratory contains a two-stage sliding-vane air compressor of German origin delivering, through a system of control valves, to three receivers from which high-pressure air can be piped as required. A special apparatus exists for the study of flame propagation in explosive gaseous mixtures. There is also a test bed provided with a swinging-field D.C. machine with switch gear and loading resistances of 40 h.p. which can be used either as a dynamometer for measuring the output of a prime mover or for driving blowers, compressors, etc. An exhauster plant is available for suction experiments. Space has been allocated for the construction of a supersonic wind tunnel, which is now well advanced.

A new vibrations laboratory is being equipped for the study of vibrations of mechanical parts, and for research.

Special apparatus is available for heat transfer measurements.

Workshops

These have now undergone extensive reconstruction, many of the machine tools having suffered severe depreciation during the war and some being obsolete. These have been replaced by new machines

of the latest design, and the change of the power supply from D.C. to A.C. has enabled all the new machines to be motorized and many of the existing machines to be converted. The removal of line and countershafting has permitted a system of fluorescent lighting to be installed. All students of the College take a workshop course and have the opportunity of gaining some insight of modern production methods. In addition, the workshop can manufacture gear for College purposes in accordance with the most exacting standards of precision engineering.

A separate shop has been allotted to research students to enable them to construct their own special apparatus. In addition to machine tools, including cylindrical and surface grinders, this shop has been provided with sheet metal working tools and oxy-acetylene and spot welding equipment. Electric heat-treatment furnaces are installed conveniently accessible to the workshops and the laboratories.

Undergraduate Courses.

First Year Students.

The first year course is common to Aeronautical, Civil, Mechanical and Electrical Engineering students. Chemical Engineers take a special course (*see* below).

Courses in Engineering Drawing, Workshop, Strength of Materials, Applied Heat and Theory of Machines are taken in the Mechanical Engineering Department, while Mathematics and Applied Electricity are studied in the Departments of Mathematics and Electrical Engineering respectively. In the second half-session Theory of Structures and Fluid Mechanics are studied in the Department of Civil Engineering.

At the end of the session students take Part I of the Final Examination, consisting of seven papers as follows :—

Mathematics	2 papers.
Applied Mechanics	2 papers.
Applied Heat	1 paper.
Engineering Drawing	1 paper.
Applied Electricity	1 paper.

The papers in Applied Mechanics include Strength of Materials, Theory of Machines, Theory of Structures and Fluid Mechanics.

Second Year Students.

Courses in Strength of Materials, Thermodynamics, Theory of Machines and Fluid Mechanics are taken in the Mechanical Engineering Department, while Mathematics, Electrical Engineering and Theory of Structures are studied in the respective Departments. A course of Metallurgy is taken in the Royal School of Mines. At the end of the session students take Part II of the Final Examination, consisting of eight papers as follows :—

Mathematics	1 paper.
Thermodynamics	1 paper.
Strength of Materials	1 paper.

Theory of Machines	1 paper.
Fluid Mechanics	1 paper.
Mechanical Engineering 1	1 paper.
Mechanical Engineering 2	1 paper.
Electrical Engineering	1 paper.

Third Year Students.

All students take in their first term courses in the following compulsory subjects :—

Properties of Engineering Materials,
Applied Thermodynamics,
Mechanical Laboratory and/or courses at L.S.E.
Design.

In the second and third terms, students take optional subjects chosen from the following :—

Fluid Mechanics,
Heat Transfer,
Industrial Administration,
Mathematics,
Structures,
Surveying,
Gas Turbines,
Engine Stressing,
Special Task.

The options are arranged to suit both the students taking Mechanical Engineering as a general training for a career in any branch of engineering industry and students wishing to specialize in the Mechanical Engineering branches of engineering science.

Wherever necessary lectures are supplemented by tutorial classes and by course work.

Chemical Engineering Students.

Courses are specially arranged in Strength of Materials, Applied Thermodynamics, Fluid Mechanics and Design. These extend, together with courses in the Chemistry Department, over two years, and include slightly more than the first-year course for other engineering students.

Undergraduate Syllabuses.

First Year

M.E.1. Engineering Drawing.

Mr. Cawley (Lectures) ; Messrs. Cawley, Beal, Cole, Dallender, and Tyler (Tutorial).

First Half-Session.—The principles of orthographic projection in relation to simple solids and applied to practical machine drawing. Descriptive geometry, including curves of interpenetration, development of surfaces, lines in space and planes showing their traces and true inclinations to planes of projection. Machine drawing, including fully dimensioned working drawings of machine parts. Assembly drawings of simple machines illustrating modern drawing office practice. Free-hand sketching.

Second Half-Session.—The design of component parts of machines, strength and suitability of the materials of construction, factor of safety, etc. Calculations for the design of simple bolt fastenings and riveted joints.

The drawings made during the second half session are of a more general character and the student learns to read difficult drawings and deduce new views from those given.

M.E.2. Workshop.

Superintendent.—Mr. Dubbins.

Intruction is given in machine tool work and in the use of engine, capstan and turret lathes, plain, vertical and universal milling machines, shaping, planing and slotting machines, pillar and radial drilling machines. Students are also taught forging, welding, filing, scraping, marking out and fitting.

The practical work is supplemented by lectures on the use and care of fine tools, the micrometer, the vernier, the origin of the flat surface, correct cutting tool angles, etc.

M.E.3. Strength of Materials.

Dr. Lewitt, Mr. Hoyle (Lectures and Tutorial); Prof. Ford and Mr. Dallender (Tutorial).

The elastic properties of materials, elastic limit, yield, fracture. Nominal and true stresses, working stresses, simple dynamic stresses, temperature stresses. Creep and fatigue. Strain energy. Shearing force and bending moment diagrams. Relation between load, shear, bending moment, slope and deflection. Theory of simple bending and deflection. Application to cantilever and supported beams. Shear stress, Modulus of Rigidity. Torsion of circular shafts. Close-coiled helical springs. Combined bending and direct stresses.

M.E.4. Applied Heat.

Mr. Dyson (Lectures); Messrs. Moore, Dallender and Beal (Tutorial).

Thermodynamic systems and boundaries. State, property, process and cycles. Laws of thermodynamics. Internal energy. Energy equation. Flow and non-flow processes. The perfect gas. Constant specific heats. Enthalpy. Expansion and compression of gases. Air compressors. Constant volume. Diesel and constant pressure cycles and their efficiencies. Carnot cycle for air. Reversibility. Entropy.

Properties of vapours. Steam tables. Elements of steam power plant. Rankins cycle. Temperature-entropy diagram for steam. Reciprocating steam engine-indicator diagrams, thermal efficiency and losses. Combustion. Boiler efficiencies. Flue gas analysis. Combustion losses.

M.E.5. Theory of Machines.

Mr. Treharne and Mr. Chalk (Lectures); Messrs. Collins, Treharne, Hoyle, Beal and Chalk (Tutorial).

Force, work, energy. Flywheels, balancing of rotating masses. Simple types of spring-loaded governors. Friction of unlubricated

surfaces, friction clutches, belt and rope drives. Wheel teeth, gear trains, epicyclic trains. Cams. Simple slide-valve motion. Velocity diagrams. Gravity-loaded governors. Piston acceleration, acceleration diagrams.

M.E.6. Mechanical Engineering Laboratory.

Dr. Heywood, Messrs. Chalk, Moore, Dallender, Hoyle, and Peerless.

The Laboratory Course gives training in experimental observation and in the recording of experimental work. Students carry out fundamental experiments for determining the elastic constants of materials in tension, compression, bending and torsion, using the various testing machines.

Tests on boilers, simple and compound steam engines, and gas engines are made, the results of the trials worked out and heat balance sheets drawn up.

M.E.7. Strength of Materials. *For Chemical Engineers.*

Dr. Lewitt (Lectures and Tutorial).

As for M.E.3 together with : Relation of elastic constants strain-energy in shafts and beams, helical springs. Distribution of shear stress in beams, principal stresses and strains, combined bending and torsion of shafts.

M.E.8. Applied Thermodynamics. *For Chemical Engineers.*

Dr. Heywood (Internal Combustion Engines) and Mr. Cole (Steam Power) (Lectures and Tutorial).

Laws of perfect gases, air compressors, combustion of gaseous liquid and solid fuels. Variation of specific heat. Internal combustion engine and gas turbine cycles. Engine testing and heat balance determination.

Steam Power : Forms of energy, properties of gases and vapours, especially steam. Fuels and combustion. Steam boiler plant. Steam engines, simple and compound. Flow of steam through nozzles. Theory of steam turbines.

M.E.9. Fluid Mechanics. *For Chemical Engineers.*

Dr. Lewitt (Lectures and Tutorial).

Centres of pressure. Bernoulli's equation applied to liquids and gases, vortex motion, pitot tube. Flow through orifices. Loss of head of flowing liquids. Discharge from tanks, notches and weirs. Viscosity, Reynolds experiments, principle of dimensional similarity, Reynolds and Froude numbers. Transmission of power through pipes, nozzles, flow through channels, critical velocity, Reciprocating pumps. Inpact on vanes. Water turbines. Centrifugal pumps. Boundary layer theory, the Aerofoil. Supersonic flow, Mach number. Magnus effect.

M.E.10. Mechanical Engineering Laboratory. *For Chemical Engineers.*

Dr. Heywood.

Similar to M.E.6.

M.E.11. Design. *For Chemical Engineers.*

Mr. Treharne (Lectures and Drawing Office).

Analysis of designs of simple engine and machine components to illustrate the application of basic principles of mechanics and thermodynamics, and to show the influence of physical properties of materials and manufacturing processes on the final design.

SECOND YEAR

M.E.12. Machine Design. *For Mechanical Engineers.*

Mr. Collins (Lectures and Drawing Office).

Properties and uses of the various engineering materials, production processes, influence on a design of manufacturing methods and the material used, proportions of machine elements as affected by the nature of loading, static, dynamic and thermal stresses, the need for rigidity, bearings for rotating shafts, lubricants and methods of lubrication, belt drives, toothed gearing, clutches, etc. Problems encountered in the design of boiler shells, valves, gear trains, reciprocating engine details and auxiliary equipment.

In the Drawing Office machine elements are sketched, drawn and analysed, existing designs of machine parts are drawn and analysed for stresses, etc., ink tracings are made and the method of reproduction of prints is demonstrated.

M.E.13. Strength of Materials. *For Mechanical, Electrical and Civil Engineers.*

Mr. Hoyle and Mr. Grootenhuis (Lectures), Prof. Ford, Messrs. Hoyle, and Grootenhuis (Tutorial).

Strength of Materials :—Stress and strain in two and three dimensions. Poisson's ratio, hydrostatic stress, Bulk Modulus, dilatation. Principal stresses and strains, Mohr's stress circle. Plane stress, equilibrium equations in two dimensions. Combined bending and torsion. Axially symmetrical systems of stress and strain, centrifugal stresses, thick cylinders and compound cylinders and temperature stresses. Distribution of shear stress in beams, shear centre. Strain energy in complex stress systems.

Vibrations.—Necessary properties of vibrating systems, nomenclature. Free and maintained vibrations of a system with one degree of freedom. Damped vibrations. Response and resonance. Energy methods for the solution of vibration problems. Systems with several degrees of freedom. Normal modes and frequencies. Continuous systems, vibration of beams.

The course aims at the application of the fundamental equations of vibrating systems to typical problems in civil, electrical and mechanical engineering.

M.E.14. Thermodynamics (*a*). *For Mechanical Engineers.*

Dr. James (Lectures and Tutorial) ; Mr. Grootenhuis (Tutorial).

A further treatment of parts of subject in M.E.4. Properties of gases, gas mixtures, volumetric heats, variable specific heats.

Mixtures of gases and vapours. Construction and use of entropy charts for gases and vapours. Air compressors, Multi-stage compression. Steam cycles, Rankin's cycle with incomplete expansion. Compounding. Regenerative, reheating and binary vapour cycles. Condensers. Flow of compressible fluids, nozzles. Impulse steam turbines, blade and stage efficiencies, pressure and velocity compounding, condition curves.

M.E.15. Thermodynamics (b). *For Mechanical Engineers.*

Dr. James (Lectures and Tutorial) ; Mr. Grootenhuis (Tutorial).

Theory of combustion. Dissociation, equilibrium constants. Internal combustion engine cycles, effect of variable specific heats and dissociation. Effect of air-fuel ratio. Gas turbines, open cycles, the regenerative cycle.

Dr. Fishenden (Lectures) ; Mr. Grootenhuis (Tutorial).

Simple theory of heat transfer by radiation, conduction and convection. Applications to industrial problems, including heat exchanges.

M.E.16. Fluid Mechanics. *For Mechanical Engineers.*

Dr. Lewitt (Lectures and Tutorial). Mr. Tyler (Tutorial).

Flow through orifices and mouthpieces. Loss of head due to abrupt changes of section. Discharge from tanks, notches and weirs. Pipe flow, losses due to friction, viscosity, principle of dimensional similarity, Reynolds and Froude numbers, non-dimensional constants. Transmission of power through pipes, nozzles, flow through channels, hydraulic jump, critical velocity. Reciprocating pumps. Impact on vanes. Water turbines. Specific speed. Model testing. Centrifugal pumps. Boundary layer theory, Aerofoils. Supersonic flow, Mach numbers. Magnus effect.

M.E.17. Theory of Machines. *For Mechanical Engineers.*

Mr. Dyson (Lectures and Tutorial), Mr. Treharne (Tutorial).

A further treatment of parts of the subject in M.E.5 together with equivalent dynamical systems, acceleration diagrams, Coriolis component, cams, inertia force and torque, turning moment diagrams. Balance of reciprocating masses. Couplings between non-axial shafts.

M.E.18. Mechanical Laboratory. *For Mechanical Engineers.*

Dr. Heywood and Prof. Ford, Messrs. Chalk, Moore, Dallender, and Turner.

Students are taught to use the various testing appliances and tests are made on several engines and turbines.

M.E.19. Laboratory Practice.

Dr. Heywood (Lectures).

Methods of testing materials, both scientific and commercial. Testing of steam plant and internal combustion engines.

M.E.20. Mechanical Laboratory. *For Civil Engineers.*

Messrs. Chalk and Moore.

A course on the testing of the strength of materials in tension, torsion, bending, shear, fatigue and hardness.

M.E.21. Theory of Machines, Thermodynamics, Heat Transfer. *For Electrical Engineers.*

Mr. Dyson, Dr. Heywood and Professor Saunders (Lectures).

Machines.—Equivalent dynamical systems, inertia forces, inertia torque, acceleration diagrams, Coriolis, balancing of reciprocating masses. Cams. Miscellaneous mechanisms.

Thermodynamics.—Summary of laws of perfect gases. Multi-stage air compressors. Comparison of engine cycles and efficiencies. Combustion calculations. Effect of mixture strength. Fuel injection systems. Temperature-entropy and enthalpy-entropy charts. Equation for steady flow of steam. Flow through nozzles. Design of blading. Compounding of stages for steam turbines. Modern power plant circuits.

Heat Transfer.—Elementary processes of heat transfer by radiation, conduction and convection ; Heat transfer problems using surface and overall heat transfer coefficient. Relative importance of liquid, gas and solid heat transfer in practical applications ; Relation of heat transfer to friction loss in forced draught cooling.

M.E.22. Design. *For Electrical Engineers.*

Mr. Treharne (Lectures and Drawing Office).

Principles and details of the design of machine components. properties of materials used in their construction, influence of choice of material, strength, rigidity, manufacturing processes and limits on the final form of components. Sketching. Production of working drawings, tracing.

M.E.23. Mechanical Laboratory. *For Electrical Engineers.*

Dr. Heywood, Messrs. Chalk and Moore.

Similar to M.E.18.

Third Year

M.E.24. Strength of Materials. (Autumn Term.)

Prof. Ford. (Lectures and Tutorial) and Mr. Turner (Tutorial).

Systems of stress and strain in three dimensions. Normal and shear stresses in terms of principal stresses. Mohr's planes for triaxial stress and strain. Stress analysis. Elastic strains in three dimensions.

Theories of elastic failure, and applications in the choice of working stresses in components subjected to complex stress conditions, and to repeated stresses. Creep.

M.E.25. Applied Thermodynamics. (All 3 Terms).

Dr. James (Lectures) ; Mr. Grootenhuis (Tutorial).

A continuation of M.E.14 and 15.

Steam turbines, reaction turbines. Back pressure, mixed pressure turbines. Evaporators, accumulators. Refrigeration, vapour compression and absorption machines, multiple effect cycle, the heat pump.

Dr. Glaister, Mr. Treharne and Mr. Cole.

Continuation of M.E.14 and M.E.15 with reference to internal combustion engines and including engine cooling, carburation and supercharging. Compression ignition engines.

M.E.26. Advanced Mechanics and Theory of Machines. (Spring Term).

Mr. Collins.

Continuation of M.E.17. Further consideration of inertia force and torque. Torsional vibration of multi-mass systems. Dampers, vibration recorders.

M.E.27. Design. (All 3 Terms).

Mr. Collins.

Analysis of stresses arising in machine and engine components subject to complex static and dynamic loading ; original design of internal combustion engine and gas turbine components and accessories, showing applications of the principles considered in the other sections of the Course.

The following are optional courses :—

M.E.28. Industrial Administration. (Autumn Term).

M.E.29. Fluid Mechanics. (Spring and Summer Terms).

Prof. Saunders and Mr. Tyler.

Energy equation of steady flow, fundamental properties of flow through ducts. One dimensional flow, isentropic flow through nozzles, flow through ducts. Theory of shock waves. Flow with friction. Flow with heat exchange. Combustion waves in pipes. Measurement of flow.

Two dimensional flow. Visualization of flow (striation interference, open channel analogy). Isentropic flow around a corner. Graphical analysis of supersonic flow (method of characteristics). Shockless nozzle. Oblique shock wave. Shock-polar.

M.E.30. Heat Transfer. (Autumn Term).

Prof. Saunders and Dr. Fishenden.

Basic laws of heat transfer by radiation, conduction and convection, and in the evaporation of liquids and condensation of vapours and their application to industrial and design problems.

M.E.31. Mechanical Engineering Laboratory. (Autumn Term).

Prof. Ford, Dr. Glaister and Messrs. Moore, Grootenhuis, Dallender, Turner and Peerless.

Strength of materials. Use of resistance strain gauges in stress analysis; impact testing; anisotropy in sheet metals; the stress-strain curve for non-ferrous metals. Internal combustion engines and steam power: more advanced experiments generally supplementing courses M.E.25, M.E.33 and M.E.35; high-speed petrol and compression-ignition engines; air compressors; nozzle tests; impulse steam turbine. Examination of liquid fuels and lubricating oils.

Postgraduate Courses.

These courses are arranged primarily for students who have obtained the Degree of the University, the Associateship of the City and Guilds Institute or an equivalent qualification.

A full time course extending over the period of a year is provided in advanced prime movers and includes the following subjects :—

M.E.32. Strength of Materials. (Spring and Summer Terms).

Prof. Ford (Lectures and Tutorial).

Application of the theory of elasticity to engineering problems :—General stress and strain equations in two and three dimensions. Cartesian and polar co-ordinates. Compatibility equations, stress functions and their application to general theory of beams, plates, stresses resulting from point and line loads, etc. Stress concentration causes by holes and other changes of section. St. Venant's theory of torsion for prismatic bars. Introduction to the theory of plasticity :—Laws of plastic deformation. Stress-strain relations, logarithmic strain, plastic tension, compression and torsion. Plane plastic deformation, plastic bending of beams. Mechanical processes for the deformation of metals.

M.E.33. Internal Combustion Engines and Gas Turbines. (All 3 Terms).

Dr. Glaister, Mr. Cole and Mr. Treharne.

Advanced theory of reciprocating engines, engine cooling, supercharging, carburation, and the compression ignition engine. Gas-turbine cycles, the characteristics of centrifugal and axial flow compressors and turbines, combustion, component matching and equilibrium running.

M.E.34. Engine Stressing. (Spring Term).

Mr. Hoyle.

Deflection of long continuous beams resting on many elastic supports. Stresses in gas turbine discs due to temperature, rotation, and external load. The Donath method of stressing. Stresses in an element of irregular shape due to rotation and temperature. Allowance to be made for yield and creep when calculated stresses are above elastic limit.

M.E.35. Coal and Steam Power. (Summer Term).

Dr. Heywood.

Sources of energy available for power production. Formation and properties of coals. Coal cleaning and carbonization. History of steam power. Description of modern steam power cycles and steam turbine construction, construction of high pressure boilers. Pulverized fuel. Air heaters. Flue gas cleaning processes.

M.E.36. Aircraft Propulsion. (All 3 Terms).

Dr. Glaister and Mr. Cole.

A course of lectures and exercises given to Students of the Aeronautics Department, consisting of two lectures ($2\frac{1}{2}$ hours) and one tutorial class (3 hours) weekly throughout the Session. The scope is in general similar to the postgraduate course in I.C. Engines and Gas Turbines, with more detailed treatment of special aircraft applications.

The piston engine lectures deal with the characteristics of the spark-ignition engine, fuels, combustion, supercharging and superchargers, carburation, air and liquid cooling, radiators, altitude performance. The gas turbine lectures deal with simple, regenerative, and reheat cycles, gas dynamics, performance estimates of propeller turbine and simple jet engines. Principles of axial-flow compressor and turbine design. Combustion. Mechanical design. Rocket motors.

Postgraduate students also take :

M.E.28. Industrial Administration,
M.E.29. Fluid Mechanics, and
M.E.30. Heat Transfer.

MECHANICAL ENGINEERING
FIRST YEAR

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Autumn Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Mathematics Lecture M.31.	Mathematics Lecture M.31.	Electrical Laboratory E.E.4.	Applied Elect. Lecture E.E.3.
11–12.		Applied Elect. Lecture E.E.3.	Strength of Materials Lecture and Tutorial		Theory of Machines Lecture and Tutorial M.E.5.
12–1.	Special Lecture	Engineering Drawing Lect. M.E.1.			
2–5.	Engineering Drawing M.E.1.	Mathematics Tutorial M.31.	—	Engineering Drawing M.E.1.	Workshop or Laboratory M.E.2 or M.E.6.
		Spring Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Mathematics Lecture M.31.	Mathematics Lecture M.31.	Electrical Laboratory E.E.4.	Applied Electricity Lecture E.E.3.
11–12.		Applied Elect. Lecture E.E.3.	Strength of Materials/ Structures Lecture and Tutorial M.E.3 or C.E.101.		Theory of Machines Fluid Mechanics/ Lecture and Tutorial M.E.5 or C.E.102.
12–1.	Special Lecture	Engineering Drawing Lecture M.E.1.			
2–5.	Engineering Drawing M.E.1.	Mathematics Tutorial M.31.	—	Theory of Machines (D.O.) M.E.5.	Workshop or Laboratory M.E.2 or M.E.6.
		Summer Term.			
10–11.	Applied Heat Lecture and Tutorial M.E.4.	Mathematics Lecture M.31.	Mathematics Lecture M.31.	Electrical Laboratory E.E.4.	Applied Electricity Lecture E.E.3.
11–12.		Applied Elect. Lecture E.E.3.	Structures Lecture and Tutorial C.E.101.		Fluid Mechanics Lecture and Tutorial C.E.102.
12–1.	Special Lecture	Engineering Drawing Lect. M.E.1.			
2-5.	Engineering Drawing M.E.1.	Mathematics Tutorial M.31.	—	Theory of Machines (D.O.) M.E.5.	Workshop or Laboratory M.E.2 or M.E.6.

MECHANICAL ENGINEERING

SECOND YEAR

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Autumn Term.			
10–11.	Electrical Engineering Lecture E.E.23.	Fluid Mechanics Lecture and Tutorial M.E.16.	Strength of Materials Lecture and Tutorial M.E.13.	Machine Design or Mechanical Laboratory M.E.12 or M.E.18.	Mathematics Lecture and Tutorial M.33.
11–12.	Electrical Laboratory E.E.24.				
12–1.		Laboratory Practice Lecture M.E.19.	Mathematics Lecture M.33.		Thermo-dynamics Lecture M.E.14.
2–3.	Machine Design or Mechanical Laboratory M.E.12 or M.E.18.	Electrical Engineering Lecture E.E.23.	—	Theory of Structures Lecture and Tutorial C.E.204.	Design Lecture M.E.12.
3–4.		Thermo-dynamics Tutorial M.E.14.			Theory of Structures Lecture C.E.204.
4–5.					—
		Spring Term.			
10–11.	Electrical Laboratory E.E.24.	Fluid Mechanics Lecture and Tutorial M.E.16.	Strength of Materials Lecture and Tutorial M.E.13.	Machine Design or Mechanical Laboratory M.E.12 or M.E.18.	Mathematics Lecture and Tutorial M.33.
11–12.					
12–1.	Thermo-dynamics Lecture M.E.15.	Theory of Machines Lecture M.E.17.	Mathematics Lecture M.33.		Machine Design M.E.12.
2–3.	Machine Design or Mechanical Laboratory M.E.12 or M.E.18.	Metallurgy Laboratory Met. 13.	—	Metallurgy Met. 13.	Thermo-dynamics Lecture M.E.14.
3–4. 4–5.				Theory of Machines Tutorial M.E.17.	Thermo-dynamics M.E.14.

MECHANICAL ENGINEERING

SECOND YEAR—*continued*

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
		Summer Term.			
10–11.	Thermo-dynamics Lecture M.E.15.	Machine Design or Hydraulics Laboratory M.E.12.	Strength of Materials Lecture and Tutorial M.E.13.	Hydraulics Laboratory or Machine Design M.E.12.	Mathematics Lecture and Tutorial M.33.
11–12.	Fluid Mechanics Lecture and Tutorial M.E.16.		Mathematics Lecture M.33.		Machine Design M.E.12.
12–1.					
2–3.	Theory of Machines Lecture and Tutorial M.E.17.	Tutorial or Hydraulics Laboratory	—	Hydraulics Laboratory or Tutorial	Thermo-dynamics Lecture M.E.14.
3–4.					Thermo-dynamics Tutorial M.E.14.
4–5.					

DEPARTMENT OF GEOLOGY

(Geology, Mining Geology and Oil Technology.)

The Department of Geology, which includes Geology, Mining Geology and Oil Technology, occupies the third and fourth floors of the Royal School of Mines Building, Prince Consort Road. Instruction given in the Department falls into three divisions: (1) broad general training in the principles of Geology for all categories of students, (2) specialised training for students who propose to make one of the above branches their career and (3) training in research methods for postgraduate students. The buildings and equipment of the Department are designed to provide facilities for these three types of training.

For the instruction in general geology there are available two large laboratories capable of accommodating about 100 students. These laboratories are furnished with petrological microscopes, maps and collections of crystals, minerals, rocks and fossils. The main Lecture Theatre accommodates over 150 students and has two projection lanterns and a projection polariscope. The Murchison Museum is an exceptionally well-lit and spacious hall in which suitable displays of geological material are provided. A large quantity of this exhibited material and of that housed in the Museum has been presented by former students who have worked abroad, especially in the Dominions and Colonies. There have thus been acquired representative collections of the greatest value for teaching and reference purposes.

For students specialising in geology and for research students, there are laboratories equipped for the different branches of the subject. The Mineralogy and Petrology Laboratories are furnished with advanced microscopes, optical apparatus and extensive collections of minerals and rocks and their accompanying thin sections. Smaller laboratories are devoted to chemical analysis, optical work and spectrographic examination of minerals. Research workers in mineralogy and petrology are catered for in a well-lit laboratory divided up into research cubicles. In this Petrology Research Laboratory are housed a complete collection of the Government geological maps of Great Britain and Ireland and a valuable series of geological maps of many other parts of the world. Drawing tables, tracing tables, a large pantograph and other facilities enable teaching and research in Structural Geology, and drafting for general research purposes, to be carried out. A Rock-cutting Room is equipped for cutting and grinding mineral- and rock-sections. A large Dark-room is available for photographic work and in it is housed a specially-designed instrument for photomicrography. The Palæontology Laboratory and Museum contain over 30,000 fossils classified and catalogued, representing all geological periods and collected from many parts of the world. For specialised work in Micropalæontology, essential in oilfield exploration, there is a research laboratory equipped with microscopes and reference collections. The Mining Geology Laboratory and Mining Geology Research Laboratory are fitted with apparatus and reagents for the study of ore-minerals and with modern optical instruments for use in Ore-microscopy. A spectrometer and quartz spectrograph are provided, especially for detecting the presence of trace

elements in minerals and rocks. Very extensive collections of economic minerals and of specimens illustrating important mining fields are also available. In the Oil Technology section, a laboratory has been set aside for the analysis and study of asphalts, crude oils and natural gases and some of their derived products. Special apparatus is provided for the study of the properties and treatment of drilling muds and there are facilities for the analysis of oilfield brines. Equipment is also available for the examination of cores from oil wells, the measurement of permeability and porosity in reservoir rocks, and the collection of data necessary for the estimation of underground oil reserves. A room has been specially fitted for the study of aerial photographs of which there is a collection from various parts of the world showing typical geological features. Considerable attention is devoted to the use of geophysical methods of exploration, both in connection with field mapping and also in the measurement of borehole data. Apparatus of the type used in large scale oilfield exploration work is available both in the Geology Department and the Physics Department. A large laboratory is provided for research on oil reservoir conditions, and other problems associated with the production of petroleum ; this laboratory is available for general research purposes and is fitted with a balance room, a small workshop and a compartment for high-pressure work.

The Department of Geology is fortunate in possessing the Watts Library of Geology containing more than 7,000 bound and 2,500 unbound volumes. There is reading accommodation for 30 students. An additional special feature is the collection of some 25,000 geological pamphlets which proves of great assistance to research workers and advanced students.

Undergraduate Courses.

Students proposing to take up any geological career will find a preliminary knowledge of chemistry and physics essential, whilst a knowledge of elementary biology is desirable. Students would do well to obtain a working acquaintance with French and German before they enter on their courses.

As the majority of geological posts require visits or residence abroad, especially in the tropics, possible disappointment at rejection on medical grounds may be avoided by students assuring themselves of their physical fitness before entering on their training. Medical Certificates of fitness for service in the tropics may be asked for in certain cases.

(1) The General Geology course assumes no previous knowledge of the subject by the student. It is adapted to meet the needs of students of the Royal School of Mines and of the Royal College of Science, and is given in the Second Half-Session of the First Year. Field work is an essential and compulsory part of the training ; this occupies about seven days in the Easter Vacation and may be supplemented by additional single days ; *the approximate cost of travelling, board and lodging for field-work is* £10. The cost of laboratory materials, etc., for either form of the course does not exceed £2, exclusive of text books.

Students taking the Associateship (A.C.G.I.) and/or Degree Course in Civil Engineering attend in their Second Year a course in Geology

specially designed for their requirements. This course comprises General Geology and its application to Engineering. Field-work, lasting about seven days, is done during the Easter Vacation, is compulsory and *involves an expense of about* £10.

(2) The specialised courses are taken in the two final years, and lead to the B.Sc. Degree and/or the Associateship in Geology (A.R.C.S.), Mining Geology (A.R.S.M.) or Oil Technology (A.R.S.M.). The complete courses in each branch normally require three years. A Fourth Year Course is available for students who have taken the A.R.S.M. and/or B.Sc. (Eng.) Degree in Mining and leads to the A.R.S.M. and/or B.Sc. Degree in Mining Geology.

Field-work is an essential and compulsory part of every Associateship and/or Degree Course in the Department of Geology. *The expense of this may reach about* £40 *during each of the two final years and may require travel abroad.* The requirements vary with the branch being studied, and students should consult the Professor of Mining Geology on this point in the first year of their College career.

(*a*) *Geology students* receive instruction in field-work during vacations of the Second and Third Years, and are required to make an independent geological examination, usually occupying about six weeks, of an assigned area during the vacations of the Second Year.

(*b*) *Mining Geology students* are required to devote a total of 320 hours to Practical Mining Shifts. In addition, Mining Geology students are required to qualify in tuitional field-work in Geology (and, when feasible, geophysical prospecting), together with an independent geological examination of an area assigned to them. Students working for the double diploma in Mining and Mining Geology should normally attend tuitional field-work in Geology (and, when feasible, geophysical prospecting), during the Easter vacation of the Third Year, the Summer Vacation preceding the Fourth, and the Christmas Vacation of the Fourth. The Easter Vacation of their Fourth Year is devoted to independent geological field-work.

(*c*) *Oil Technology students* are required to attend a tuitional field-work course during the vacations of the Second and Third Years. In addition, they are required to obtain practical experience on an oil-field of at least 360 hours in shifts averaging not less than six hours' duration, and to spend an equal time in independent geological investigation of an assigned area.

The courses for the Associateship and/or Degree in Geology, Mining Geology and Oil Technology are detailed below. For requirements in field-work, *see* the preceding paragraph.

GEOLOGY—

INTERMEDIATE YEAR

First Half-Session :—

Physics, P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Mathematics, Pure, M.1.

Second Half-Session :—

Chemistry C.021, C.041, C.042, C.047.
Mathematics, Applied, M.2.

FIRST YEAR

First Half-Session :—

Biology, B.1, B.1a.
Surveying, Min.6.

Second Half-Session :—

General Geology, G.1, G.2, G.3.
Physical Chemistry, C.114.

SECOND YEAR

Mineralogy, G.4, G.5.
Sedimentary Petrology, G.34, G.35.
Palæontology, G.15, G.16, G.17.
Physical Geology, G.10.
Structural Geology, G.13, G.14.
Mining Geology, First Course, G.20, G.21.
Geological Field-Work, G.38.
Engineering Geology G.43 (in part).

THIRD YEAR

Stratigraphical Geology, G.11.
Regional and Tectonic Geology, G.12.
Petrology, G.8, G.9.
Optional Subject : Mining Geology, Second Course, G.22, G.23, G.24, or some other approved Course, or in special circumstances a Dissertation on an approved geological topic.
Independent Geological Mapping, G.39.

MINING GEOLOGY—

INTERMEDIATE YEAR

First Half-Session :—

Physics, P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Mathematics, Pure, M.1.

Second Half-Session :—

Chemistry, C.021, C.041, C.042, C.047.
Mathematics, Applied, M.2.
Practical Geometry, Min.1a.

FIRST YEAR

First Half-Session :—

Assaying, Met.3.
Surveying, Min.6.

Second Half-Session :—

General Geology, G.1, G.2, G.3.
Physical Chemistry, C.114.

SECOND YEAR

Mineralogy, G.4A, G.5A.
Petrology, G.8A, G.9A.
Structural Geology, G.13, G.14.
Stratigraphical Palæontology, G.18., G.19.
Mining Geology, First Course, G.20, G.21.
Mining Geology, Second Course, G.22, G.23, G.24.
Geological Field-Work, G.38.
Independent Geological Field-Work, G.39.

THIRD YEAR

Dissertation on an Approved Topic in Mining Geology.
Physical Geology, G.10.
Geophysical Prospecting, G.36A, G.37A.
Mining Principles and Practice, Min.5.
Mine Surveying, Min.7.
Mining Economics, Min.12.
Engineering Geology, G.43 (in part).
Tropical Hygiene, Min.13.
First Aid, Min.14.

FOURTH YEAR

(For Students who have taken the A.R.S.M. and/or B.Sc. Course in Mining and who are taking in addition the A.R.S.M. and/or B.Sc. Course in Mining Geology.)

Subjects correspond with the Second Year Curriculum for Mining Geologists, with the omission of Mining Geology, First Course, and the addition of Physical Geology, Geophysical Prospecting and a report on Independent Field Study.

OIL TECHNOLOGY—

INTERMEDIATE YEAR

First Half-Session :—

Physics, P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Mathematics, Pure, M.1.

Second Half-Session :—

Chemistry, C.021, C.041, C.042, C.047.
Mathematics, Applied, M.2.
Principles of Machines, Min.1.
Practical Geometry, Min.1*a*.

FIRST YEAR

First Half-Session :—

Applied Mathematics, Part I, M.4.
Applied Mechanics, Min.2.
Graphics, Min.3.
Engineering Drawing and Design, Min.4.
Optical Mineralogy, G.6, G.7.

Second Half-Session :—

Applied Mathematics, M.4.
General Geology, G.1, G.2, G.3.
Physical Chemistry, C.114.

SECOND YEAR

Petrology with Special Reference to Sediments, G.34, G.35.
Physical Geology, G.10.
Structural Geology, G.13, G.14.
Palæontology, G.15, G.16, G.17.
Geology of Fuels, G.21.
Properties of Petroleum, G.25, G.26.
Oil-Refining Practice, G.27.
Geological Field-Work, G.38.
Oilfield Shifts.

THIRD YEAR

Oilfield Drilling, G.28 and G.29.
Geology of Petroleum, G.30 and G.31.
Structural Geology of Petroleum, G.32, G.33.
Geophysical Prospecting, G.36, G.37.
Geological Field-Work, G.38.
Independent Geological Field-Work, G.39.
Surveying, Min.6.

Geology for Civil Engineers.

SECOND YEAR

General Geology for Engineers, G.40, G.41.
Field-Work in Geology for Engineers, G.42.
Engineering Geology and Water Supply, G.43.

THIRD YEAR

Geology of Building Materials, G.44.

Syllabuses of Courses.

G.1. General Geology.

Prof. Read, Dr. Wilson, Dr. Jones, and Dr. Blyth.

About 60 lectures, on the syllabus given below. Concurrently with these :—

Dr. Gwyn Thomas and Mr. Carter.

12 lectures on Palæontology.

Prof. Williams and Mr. Millman.

15 lectures on Economic Mineralogy, for Geology, Mining Geology, Metallurgy and Mining students.

Mr. Coomber, Dr. Hobson and Mr. Fothergill.

About 12 lectures, with suitable practical work, on Oilfield Drilling and Development, followed by a course on elementary structural geology for Oil Technology students.

Syllabus.—Crystallography.—The recognition, classification, and representation of the principal crystal-forms assumed by minerals ; the use of crystal-form in identification.

Mineralogy.—The physical and chemical properties of the more common rock-forming minerals ; their classification, association, and modes of occurrence.

Petrology.—The nature, composition, and classification of igneous, sedimentary, and metamorphic rocks.

Physical Geology.—The action of air and water upon the solid earth, and its geological consequences in the destruction and renewal of the earth-crust; the forces acting upon that crust from within and their results in modifying the earth's surface, and in altering the character and distribution of its materials.

Physiographical Geology.—The nature, origin, and distribution of the greater surface features of tne earth-crust; their relation to the internal force of the earth and to the action of external agencies upon the crust.

Structural Geology.—The arrangement and inter-relations of the great rock-masses in the earth-crust and the part played by them in its architecture.

Stratigraphical Geology.—The principles on which the chronological classification of rock-masses depend; the use of the fossil remains of animals and plants in determining the age of rocks; the history of the earth-crust and of its inhabitants as revealed by the succession of formations in the British Isles.

Palæontology.—Fossils: their preservation and importance as rock-formers; classification and time-range of the chief groups.

Economic Mineralogy.—The principal minerals of economic importance; their physical and chemical characters; their determination, occurrence, and uses.

G.2. Laboratory.

Dr. Gwyn Thomas, Mr. Carter, Mr. Shearman, Mr. Millman, Mr. Ager, Mr. Cheesman and Demonstrators.

Reading and drawing of crystals; macroscopical and microscopical determination of minerals and rocks; interpretation of geological maps; examination and drawing of common fossils; blowpipe analysis of mineral powders; study of selected areas of Great Britain.

G.3. Field Work.

Under the direction of appropriate members of the staff.

During the Easter vacation a seven days' course of field work is arranged to enable students to study the stratigraphy, structure, and scenery of a selected district. Attendance at this course is compulsory.

G.4. Mineralogy.

Dr. Jones, Dr. Blyth and Mr. Walker.

A course of about 50 lectures on the identification of minerals by their crystallographic, optical, and other properties; the use of the petrological microscope and other optical apparatus. The atomic structures of silicate minerals. Systematic study of the minerals met with as constituents of rocks, their crystalline form and physical properties, chemical composition and alteration products, modes of occurrence and origin.

G.4A. Mineralogy for Mining Geology Students.

Dr. Pitcher and Mr. Walker.

As for G.4, with special emphasis on selected aspects.

G.5. Mineralogy. Laboratory Work.

Dr. Jones, Dr. Blyth and Mr. Walker.

The optical properties, identification and investigation of rock-forming minerals in hand-specimens and under the microscope.

G.5A. Mineralogy for Mining Geology Students. Laboratory Work.

Dr. Pitcher and Mr. Walker.

As for G.5, with special emphasis on selected aspects.

G.6. Optical Mineralogy for Oil Students.

Mr. Shearman.

A course of about 6 lectures on the optical properties of rock-forming minerals.

G.7. Optical Mineralogy for Oil Students. Laboratory Work.

Mr. Shearman and Mr. Walker.

The practical application of optical properties to the determination of rock-forming minerals.

G.8. Petrology.

Dr. Sutton and Prof. Read.

Sedimentary, Metamorphic, and Igneous Rocks.

A course of about 80 lectures with special emphasis on metamorphic and igneous petrology. Identification and classification of rocks; regional distribution and field occurrence; chemical changes during rock-forming processes; study of selected areas and of geological periods; review of current theories of petrogenesis.

G.8A. Petrology for Mining Geology Students.

Dr. Pitcher and Dr. Webb.

As for G.8, with special emphasis on selected aspects.

G.9. Petrology. Laboratory Work.

Dr. Sutton.

The study of a large and carefully selected series of typical rocks from all parts of the world, and of sections cut from them for examination by the aid of the microscope and by other methods.

G.9A. Petrology for Mining Geology Students. Laboratory Work.

Dr. Pitcher and Dr. Webb.

As for G.9, with special emphasis on selected aspects.

G.10. Physical Geology.

Dr. Gilbert Wilson.

A course of about 30 lectures dealing with the processes of denudation, transportation, and deposition; the formation of sediments; compaction, cementation; the major structures of sedimentary and igneous rocks; diastrophism; earthquakes; vulcanicity; faulting; folding; earth-sculpture; geological cycles; correlation; theories of the earth.

G.11. Stratigraphical Geology.

Dr. Gilbert Wilson, Dr. Gwyn Thomas, Dr. Sutton and Mr. Ager.

A course of about 80 lectures, with appropriate practical work, on the advanced study of the various Geological Systems, of their fossils, and of the igneous rocks and economic products associated with them, with emphasis on interpretation, analysis, and the principles involved. This course will deal not only with the character, classification, and distribution of British strata, but also with their foreign representatives, so as to give students a comprehensive view of geological history. One or more systems may be set as a subject for special study.

G.12. Regional and Tectonic Geology.

Prof. Read, Dr. Gwyn Thomas and Dr. Sutton.

A course of about 20 lectures and appropriate practical work (in close conjunction with G.11). The origin of continents and oceans. Palæogeographic conditions, considered broadly, during each of the chief epochs of earth-history. Earth-movements, epeirogenic and mountain-building, and their influence on sedimentation. Geological cycles. The structural units of the earth-crust.

G.13. Structural Geology.

Dr. Gilbert Wilson.

A course of about 60 lectures on geological structures involving igneous, sedimentary, and metamorphic rocks, and their relation to topographic features. Geological survey methods.

G.14. Structural Geology. Laboratory Work.

Dr. Gilbert Wilson.

The study and interpretation of geological maps.

G.15. Palæontology.

Dr. Gwyn Thomas and Mr. Carter.

(*a*) *Invertebrate.*—A course of about 75 lectures on the structure and classification of the principal groups of invertebrate fossils. Palæontological principles and methods. Technique.

(*b*) *Vertebrate.*—A general course of about 15 lectures.

G.16. Palæontology. Laboratory Work.

Dr. Gwyn Thomas and Mr. Carter.

Laboratory work appropriate to G.15.

G.17. Palæontology of the Foraminifera.

Mr. Carter.

A course of 18 lectures on the Foraminifera, with special reference to their value in oilfield correlation.

G.18. Stratigraphical Palæontology.

Mr. Carter.

A course of about 15 lectures on principles of the zoning of stratified rocks, geographical distribution, physical conditions and animal communities, facies, the faunal and floral assemblages of each Geological System.

G.19. Stratigraphical Palæontology. Practical.

Mr. Carter.

The examination of representative faunas and floras of each Geological System.

G.20. Mining Geology, First Course.

Prof. Williams.

A course of about 24 lectures on the Nature and Origin of Mineral Deposits. Mineral deposits defined; their geological significance; their form and modes of occurrence. Origin of deposits; the principal genetic processes; *e.g.*, crystallization from igneous magmas, extraction by magmatic gases, contact metamorphism, precipitation from underground and overground waters, action of organisms, concentration of products of weathering and disintegration. Classification of mineral deposits.

Primary and secondary variations in ore-deposits; ore-shoots; depth zones. Zonal distribution of metals. Mechanical deformation of ore-bodies. Surficial alteration; impoverishment and enrichment.

The geographical distribution and special geology of notable deposits or fields yielding some of the more important metals and non-metallic minerals.

G.21. Mining Geology, First Course. Geology of Fuels.

Mr. Shearman and Prof. Illing.

A course of 12 lectures on the Geology of Fuels. Peat, lignite, coal, cannel, anthracite. The origin, variations, and relations of coals and coal-measures. The distribution and tectonics of typical coalfields. Concealed coalfields.

The nature and mode of occurrence of natural gas, petroleum, and asphalt, and their connexion with coals, cannels, and oil-shales. The relations between geological structures and the occurrence of petroleum. Theories as to the origin of petroleum. The segregation, migration, fractionation, and diffusion of petroleum.

G.22. Mining Geology, Second Course.

Prof. Williams, Dr. Webb, and Mr. Millman.

A course of about 60 lectures on economic mineral deposits and genetic processes not exemplified, or not fully considered, in the First Course.

Structural control of the localisation of mineral deposits. Geological principles of ore-search; guides to the finding of ore. Field exploration; the examination of prospects; the writing and reading of reports. The nature of ore fluids; mineralisation processes. Geochemistry applied to the study of trace element behaviour during mineralisation; distribution of metallogenetic provinces; geochemical prospecting. Description of mining fields with appropriate study of collections and publications illustrating the geology and mineralisation.

G.23. Economic Mineralogy, including Ore Microscopy.

Prof. Williams, Dr. Webb and Mr. Millman.

A course of about 25 lectures on methods of determination and investigation of ore-minerals and associated minerals.

The preparation and microscopical examination of polished sections of opaque ore-minerals, and the application of ore microscopy to problems of mineral dressing; chromographic contact prints. Microchemical and fluorochemical examination; spectrographic analysis. Radioactivity of minerals; the use of radiation monitors, and autoradiographic methods. Mineral concentrates; electromagnetic and density separation.

G.24. Economic Mineralogy, Laboratory Work.

Prof. Williams, Dr. Webb and Mr. Millman.

Appropriate practical work to illustrate G.23, including chemical and physical methods of examining economic minerals, and the interpretative study of mineral relationships.

G.25. Physical and Chemical properties of Petroleum, Oilfield Brines and Drilling Muds.

Mr. Coomber and Dr. Hobson.

A course of about 40 lectures on the composition, examination and physical properties of oilfield waters, natural gas and petroleum; the viscometric properties of true and anomalous liquids; the composition, examination and physical properties of drilling muds.

G.26. Physical and Chemical properties of Petroleum, Oilfield Brines and Drilling Muds. Laboratory Work.

Mr. Coomber and Dr. Hobson.

A practical course of about 300 hours illustrating course G.25.

G.27. Oil Refining Practice.

Mr. Coomber.

A course of about 10 lectures on the distillation, cracking and conversion of petroleum, the fractionation of petroleum and the refining of the products ; and on the more important properties of the principal commercial petroleum products.

G.28 and G.29. Oilfield Drilling and Development.

Mr. Coomber.

A course of 40 lectures on preparatory work, water supply, communications, well sites. Drilling methods, completion of wells, equipment of flowing wells, gas lift, pumping methods.

Secondary recovery methods.

Transport and storage.

G.30 and G.31. Geology of Petroleum and Natural Gas.

Prof. Illing, Dr. Hobson and Mr. Fothergill.

A course of about 50 lectures, accompanied by appropriate study of original papers and memoirs, on the nature of oil accumulations ; their mode of formation and preservation ; types of oil-bearing structure ; reservoir pressure ; oil shows and their significance ; basic principles of the search for oil ; geological and geographical distribution of oilfields.

G.32. Structural Geology of Petroleum.

Prof. Illing, Dr. Hobson and Mr. Fothergill.

A course of 40 lectures on the classification of oilfield structures ; representation and manipulation of data ; well logging ; well surveying ; interpretation of electric logs ; porosity, permeability, fluid distribution ; mechanics of production, control, well spacing ; estimation of reserves ; principles of secondary recovery.

Aerial photographs as sources of geological data.

G.33. Structural Geology of Petroleum. Laboratory.

Dr. Hobson.

Suitable laboratory and class work to illustrate G.32.

G.34. Petrology with special reference to Sediments.

Mr. Shearman.

A course of lectures on the lithology, mineral composition, genesis and alteration of the sedimentary rocks. Qualitative and quantitative methods of study. Correlation.

G.35. Petrology with special reference to Sediments. Practical.

Mr. Shearman and Mr. Walker.

Suitable laboratory work to illustrate G.34.

G.36. Principles of Geophysical Prospecting for Oil Students.

Dr. Bruckshaw and Mr. Mason.

A course of about 25 lectures on the principles of seismic, gravimetric and magnetic methods of geophysical prospecting, their applications and limitations ; interpretation of results : electrical and radio-active well logging.

G.36A. Geophysical Prospecting for Mining Geology Students.

Dr. Bruckshaw.

A course similar to G.36.

G.37. Principles of Geophysical Prospecting for Oil Students. Practical.

Dr. Bruckshaw and Mr. Vincenz.

Suitable class work and laboratory work to illustrate G.36.

G.37A. Geophysical Prospecting for Mining Geology Students. Practical.

Dr. Bruckshaw and Mr. Mason.

As G.37, and field work.

G.38. Geological Surveying.

By appropriate Members of the Staff.

Practical courses in geological mapping of selected areas are arranged during vacations and other times for all students going out in Geology, Mining Geology, and Oil Technology. Attendance at these courses, which occupy at least 21 days in each of the last two sessions, is compulsory.

G.39. Independent Geological Surveying.

Under direction of appropriate Members of the Staff.

During one of the vacations in their second or third year, students going out in Geology, Mining Geology, or Oil Technology, are required to make an independent geological survey of an assigned area. This field-work normally occupies at least six weeks, and is followed by laboratory and office work necessary for the completion of map and report.

G.40. General Geology for Engineers.

Dr. Blyth.

A course of 20 lectures on selected aspects of geology, including the modification of landscapes by wind, water, and ice ; nature and formation of sedimentary deposits ; igneous and metamorphic rocks. Rock structures and relationships ; earthquakes. The chief British formations and their salient characteristics.

G.41. General Geology for Engineers. Laboratory Work.

Dr. Blyth, Mr. Shearman, and Mr. Ager.

Microscopic characters of rock-forming minerals. Examination of rocks in hand-specimens and thin-sections. The interpretation of geological maps, and the construction of sections. Discussion of selected areas.

G.42. Field-work for Engineers.

By appropriate Members of the Staff.

Seven days' field-work in geology, held during the Easter vacation. The principles of geological mapping. Attendance at this course is compulsory.

G.43. Engineering Geology and Water Supply.

Dr. Blyth.

A course of lectures on the geology of water supply from surface and underground resources ; the principles which govern the collection and storage of supplies and the conditions which regulate their quality and quantity. The geology of reservoir and dam sites, tunnels, etc. Stability of slopes. The effects of shifting materials, either by human or natural agencies, in connexion with engineering works.

G.44. Geology of Building Materials.

Dr. Blyth, Prof. Williams, and Dr. Jones.

A course of 9 lectures on sands and aggregates, the raw materials of cements and refractories, natural building stones, cast stone, and road metals. Each lecture will be followed by appropriate practical work or demonstration.

Tropical Hygiene.

A short course of six lectures dealing with simple precautions for preserving health in the tropics, given in the Mining Department towards the end of the second half-session just after College hours. The attendance of students, though optional, is strongly recommended.

First Aid to the Injured.

Before Christmas a course of six lectures, followed by exercises, given in the Mining Department in the evenings under the St. John Ambulance Association. Attendance is open to all students at a fee of five shillings, and successful candidates at the examination are awarded certificates.

Postgraduate Courses.

Students who have completed satisfactorily the course in Geology, Mining Geology or Oil Technology for the Associateship and/or B.Sc. degree, or who satisfy the Authorities of the Imperial College that they have done equivalent work, may proceed to more advanced work in their subject or in special branches of it, leading to the Diploma of the Imperial College and/or higher degrees. Graduates of other Universities who are not considered fully qualified may be required to attend the final year undergraduate course before proceeding to research or advanced study.

This work may consist of :—

(*a*) Research ;

(*b*) A course of reading and laboratory work to meet individual needs.

Applications for postgraduate places are normally considered in the first week in May ; Candidates are therefore advised to apply by 1st May. They should consult the Professor of Mining Geology before making application.

GEOLOGY

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Biology B.1.	Surveying Min. 6.	Biology B.1.	Surveying Min. 6.	Biology B.1.
11–12.	Biology B.1A.		Biology B.1A.		Biology B.1A.
12–1.					
2–3.	Biology B.1A.	Surveying Min. 6.	Biology B.1A.	Surveying Min. 6.	Surveying Min. 6.
3–4.					
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.
12–1.		Physical Chemistry Lecture C.114.		Palæontology Lecture G.1.	
2–3.	Physical Chemistry Lecture C.114.	(*a*) Economic Mineralogy Lecture G.1.		(*a*) Economic Mineralogy Lecture G.1.	
3–4.	Geology Laboratory G.2.	Economic Mineralogy Laboratory G.2.	Geology Laboratory G.2.	Economic Mineralogy Laboratory G.2.	Palæontology Laboratory G.2.
4–5.					

(*a*) From end of February ; before, Economic Mineralogy Laboratory, G.2.

GEOLOGY

SECOND YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Mineralogy Lecture G.4.	Palæontology Lecture G.15 (G.17).	Palæontology Lecture G.15 (G.17).	Palæontology Lecture G.15 (G.17).	Mineralogy Lecture G.4.
11–12.	Mineralogy Laboratory G.5.	Palæontology Laboratory G.16.	Palæontology Laboratory G.16.	Palæontology Laboratory G.16.	Mineralogy Laboratory G.5.
12–1.	Mining Geology First Course Lecture G.20, G.21.		Mining Geology First Course Lecture G.20, G.21.		Mining Geology First Course Lecture G.20, G.21.
2–3.	Mineralogy Laboratory G.5.	Structural Geology Lecture G.13.	Tutorial Work or Reading or Revision	Physical Geology Lecture G.10.	Structural Geology Lecture G.13.
3–4.		Palæontology Laboratory G.16.		Mineralogy Laboratory G.5.	Structural Geology Laboratory G.14.
4–5.					

SECOND YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Mineralogy Lecture G.4.	Palæontology Lecture G.15 (G.17).	Palæontology Lecture G.15 (G.17).	Petrology of Sediments G.34.	Petrology of Sediments Lecture G.34.
11–12.	Mineralogy Laboratory G.5.	Palæontology Laboratory G.16.	Palæontology Laboratory G.16.	Petrology of Sediments Laboratory G.35.	Petrology of Sediments Laboratory G.35.
12–1.				Palæontology Lecture G.15.	Water Supply Lectures G.43. (Summer Term).
2–3.	Mineralogy Laboratory G.5.	Structural Geology Lecture G.13.	Tutorial Work or Reading or Revision	Physical Geology Lecture G.10.	Structural Geology Lecture G.13.
3–4.		Palæontology Laboratory G.16.		Mineralogy Laboratory G.5.	Structural Geology Laboratory G.14.
4–5.					

GEOLOGY

THIRD YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Special Subject	Special Subject	Petrology Lecture G.8.	Special Subject	Stratigraphical Geology G.11. or Regional and Tectonic Geology G.12.
11–12.			Petrology Laboratory G.9.		
12–1.					
2–3.	Stratigraphical Geology G.11. or Regional and Tectonic Geology G.12.	Petrology Lecture G.8.	Tutorial Work or Reading or Revision	Petrology Lecture G.8.	Palæontology Lecture G.15b.
3–4.		Petrology Laboratory G.9.		Petrology Laboratory G.9.	Stratigraphical Geology G.11. or Regional and Tectonic Geology G.12.
4–5.					

THIRD YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Special Subject	Special Subject	Petrology Lecture G.8.	Special Subject	Stratigraphical Geology G.11. or Regional and Tectonic Geology G.12.
11–12.			Petrology Laboratory G.9.		
2–3.	Special Subject	Petrology Lecture G.8.	Tutorial Work or Reading or Revision	Petrology Lecture G.8.	Stratigraphical Geology G.11. or Regional and Tectonic Geology G.12.
3–4.		Petrology Laboratory G.9.		Petrology Laboratory G.9.	
4–5.					

MINING GEOLOGY

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Assay Lecture Met. 3.	Surveying Min. 6.	Assay Laboratory Met. 3.	Surveying Min. 6.	Assay Lecture Met. 3.
11–12.	Assay Laboratory Met. 3.				Assay Laboratory Met. 3.
12–1.					
2–3.	Assay Laboratory Met. 3.	Surveying Min. 6.	Assay Laboratory Met. 3.	Surveying Min. 6.	Surveying Min. 6.
3–4.					
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.
12–1.		Physical Chemistry Lecture C.114.			
2–3.	Physical Chemistry Lecture C.114.	(*a*) Economic Mineralogy Lecture G.1.	Geology Laboratory G.2.	(*a*) Economic Mineralogy Lecture G.1.	Palæontology Lecture G.1.
3–4.	Geology Laboratory G.2.	Economic Mineralogy Laboratory G.2.		Economic Mineralogy Laboratory G.2.	Palæontology Laboratory G.2.
4–5.					

(*a*) From end of February ; before, Economic Mineralogy Laboratory, G.2.

MINING GEOLOGY
SECOND YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Economic Mineralogy Lecture G.23.	Mining Geology II Lecture G.22.	Mineralogy Lecture G.4A.	Mining Geology II Lecture G.22.	Mineralogy or Petrology Lecture G.4AorG.8A.
11–12.	Economic Mineralogy Laboratory G.24.	Economic Mineralogy Laboratory G.24.	Mineralogy Laboratory G.5A.	Economic Mineralogy Laboratory G.24.	Mineralogy or Petrology Laboratory G.5AorG.9A.
12–1.	Mining Geology First Course Lecture G.20, G.21.		Mining Geology First Course Lecture G.20, G.21.		Mining Geology First Course Lecture G.20, G.21.
2–3.	Strati-graphical Palæontology Lecture G.18.	Structural Geology Lecture G.13.	Reading and Revision	Mineralogy or Petrology G.4A or G.8A	Structural Geology Lecture G.13.
3–4.	Strati-graphical Palæontology Laboratory G.19.	Mineralogy Laboratory G.5A.		Mineralogy or Petrology Laboratory G.5AorG.9A.	Structural Geology Laboratory G.14.
4–5.					

SECOND YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Economic Mineralogy Lecture G.23.	Mining Geology II Lecture G.22.	Petrology Lecture G.8A.	Mining Geology II Lecture G.22.	Petrology or Mineralogy Lecture G.8AorG.4A.
11–12.	Economic Mineralogy Laboratory G.24.	Mining Geology II Laboratory G.22.	Petrology Laboratory G.9A.	Mining Geology II Laboratory G.22.	Petrology or Mineralogy Laboratory G.9AorG.5A.
12–1.					
2–3.	Economic Mineralogy Laboratory G.24.	Structural Geology Lecture G.13.	Reading and Revision	Petrology Lecture G.8A.	Structural Geology Lecture G.13.
3–4.		Petrology Laboratory G.9A.		Petrology Laboratory G.9A.	Structural Geology Laboratory G.14.
4–5.					

MINING GEOLOGY

THIRD YEAR—First Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Mining Geology (Special)	Geophysical Prospecting Lecture G.36A.	Mining Geology (Special)	Geophysical Prospecting Lecture G.36A.	Mining Geology (Special)
11–12.	Mining Min. 5.	Geophysical Prospecting Laboratory G.37A.	Mining Min. 5.	Geophysical Prospecting Laboratory G.37A.	Mining Min. 5.
12–1.	Mining Geology (Special)		Mining Geology (Special)		Mining Geology (Special)
2–3.	Mining Geology (Special)	Mining Geology (Special)	Geophysical Prospecting Lecture G.36A.	Physical Geology Lecture G.10.	Mining Min. 5.
3–4.			Geophysical Prospecting Laboratory G.37A.	Mining Geology (Special)	Colloquium (Mining)
4–5.					

THIRD YEAR—Second Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Mining Economics Min. 12.	Mining Economics Min. 12.	Mining Economics Min. 12.	Mining Economics Min. 12.	Mining Economics Min. 12.
11–12.	Mine Surveying Min. 7.	Mining Min. 5.	Mine Surveying Min. 7.	Mining Min. 5.	Mining* Min. 5.
12–1.					
2–3.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Physical Geology Lecture G.10.	Mine Surveying Min. 7.
3–4.				Mine Surveying Min. 7.	
4–5.					

* Water Supply Lectures (G.43), 12–1 in Summer Term.

OIL TECHNOLOGY

(*The Intermediate Year Time-Table will be found on p. 60*).

FIRST YEAR—First Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Graphics Min. 3.	Engineering Lecture and Classwork Min. 2.	Applied Mathematics M.4.	Engineering Lecture and Classwork Min. 2.	Applied Mathematics M.4.
11–12.	Applied Mathematics M. 4.				
12–1.		Reading and Revision	Graphics Min. 3.		Graphics Min. 3.
2–3.	Geology Lecture G.1.	Engineering Drawing and Design Min. 4.	Engineering Drawing and Graphics Min. 3 & 4.	Optical Mineralogy Lecture G.6.	Engineering Drawing and Design Min. 4.
3–4.	Geology Laboratory G.2.			Optical Mineralogy Laboratory G.7.	
4–5.					

FIRST YEAR—Second Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	Applied Mathematics M.4.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.
12–1.		Physical Chemistry Lecture C.114.		Palæontology Lecture G.1.	
2–3.	Physical Chemistry Lecture C.114.	Geology Laboratory G.2.	Geology Laboratory G.2.	Applied Mathematics M.4.	Geology Laboratory G.2.
3–4.	Geology Laboratory G.2.			Geology Laboratory G.2.	
4–5.					

OIL TECHNOLOGY

SECOND YEAR—First Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Properties of Petroleum Lecture G.25.	Palæontology Lecture G.15a.	Palæontology Lecture G.15a.	Palæontology Lecture G.15a. (*a*)	Petrology of Sediments Lecture G.34.
11–12.	Properties of Petroleum Laboratory G.26.	Palæontology Laboratory G.16.	Palæontology Laboratory G.16.	Palæontology Laboratory G.16. (*b*)	Petrology of Sediments Laboratory G.35.
12–1.					
2–3.	Properties of Petroleum Laboratory G.26.	Structural Geology Lecture G.13.	Reading and Revision	Physical Geology Lecture G.10.	Structural Geology Lecture G.13.
3–4.		Properties of Petroleum Laboratory G.26.		Properties of Petroleum Laboratory G.26.	Structural Geology Laboratory G.14.
4–5.					

SECOND YEAR—Second Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Properties of Petroleum Lecture G.25.	Palæontology Lecture G.15a.	Palæontology Lecture G.15a.	Petrology of Sediments Lecture G.34.	Petrology of Sediments Lecture G.34.
11–12.	Properties of Petroleum Laboratory G.26.	Palæontology Laboratory G.16.	Palæontology Laboratory G.16.	Petrology of Sediments Laboratory G.35.	Petrology of Sediments Laboratory G.35.
12–1.				Properties of Petroleum Lecture G.25.	
2–3.	Properties of Petroleum Laboratory G.26.	Structural Geology Lecture G.13.	Reading and Revision	Physical Geology Lecture G.10.	Structural Geology Lecture G.13.
3–4.		Properties of Petroleum Laboratory G.26. (*c*)		Properties of Petroleum Laboratory G.26. (*c*)	Structural Geology Laboratory G.14.
4–5.					

(*a*) For first term, then G.25. (*b*) For first term, then G.35.
(*c*) During March and May, a total of 10 lectures on Oil Refining Practice, G.27, to be arranged in these periods.

OIL TECHNOLOGY

THIRD YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Structural Geology of Petroleum Lecture G.32.	Surveying Practice Min. 6.	Principles of Geophysical Prospecting Lecture G.36.	Surveying Practice Min. 6.	Geology of Petroleum Lecture G.30.
11–12.	Structural Geology of Petroleum Laboratory G.33.		Principles of Geophysical Prospecting Laboratory G.37.		Geology of Petroleum Reading and Classwork
12–1.					
2–3.	Geology of Petroleum Lecture G.30.	Surveying Practice Min. 6.	Reading and Revision	Oilfield Drilling and Development Lecture G.28.	Oilfield Drilling and Development Lecture G.28.
3–4.	Geology of Petroleum Reading and Classwork			Surveying Practice Min. 6.	Geology of Petroleum Reading and Classwork
4–5.	Surveying Practice Min. 6.	Surveying Lecture Min. 6.		Surveying Lecture Min. 6.	Surveying Lecture Min. 6.

THIRD YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology of Petroleum Lecture G.30.	Structural Geology of Petroleum Lecture G.32.	Principles of Geophysical Prospecting Lecture G.36.	Structural Geology of Petroleum Lecture G.32.	Geology of Petroleum Lecture G.30.
11–12.	Geology of Petroleum Reading and Classwork	Structural Geology of Petroleum Laboratory G.33.	Principles of Geophysical Prospecting Laboratory G.37.	Structural Geology of Petroleum Laboratory G.33.	Geology of Petroleum Reading and Classwork
12–1.					
2–3.	Geology of Petroleum Reading and Classwork	Structural Geology of Petroleum Laboratory G.33.	Reading and Revision	Oilfield Drilling and Development Lecture G.28.	Oilfield Drilling and Development Lecture G.28.
3–4.				Structural Geology of Petroleum Laboratory G.33.	Geology of Petroleum Reading and Classwork
4–5.					

DEPARTMENT OF MATHEMATICS

General.

The Mathematics Department aims at fulfilling two functions : (*a*) to train professional mathematicians to pursue the study of scientific and technical problems by mathematical methods ; (*b*) to provide instruction in mathematics to those students who require it as ancillary to some other scientific or technological pursuit.

The scheme of instruction is consequently designed to emphasise the applications rather than the more abstract aspects of mathematics, although the study of pure mathematics is necessarily carried to an advanced stage.

The Mathematics Department (lecture rooms, staff rooms, mechanics and statistical laboratories, departmental library, and the computing bureau) is situated in the Huxley Building in Exhibition Road, South Kensington, S.W.7.

Structure of the Department.

The undergraduate work of the department is carried out by lectures, and tutorial classes. The teaching in Pure and Applied Mathematics, Mathematical Physics and Statistics is coupled with training in the use of a wide variety of computing machines, and practical work in the statistics laboratory.

Broadly, the responsibility for the conduct of this work is distributed as follows :—

Professor H. Levy, M.A., D.Sc., F.R.S.
(Head of the Department)

Mathematical Physics	Applied Mathematics	Pure Mathematics	Statistics and Practical Mathematics	Engineering Mathematics
Prof. H. Jones, Ph.D., F.R.S.	Dr. G. J. Whitrow M.A., D.Phil.	Mr. C. H. Kebby, M.Sc.	Mr. G.A.Barnard, M.A.	Mr. D. N. de G. Allen, M.A.

Lecturers, Assistant Lecturers and Demonstrators assist in the conduct of this work. Detailed syllabuses of the lecture courses are given on pp. 189–198.

The grouping of these in the undergraduate courses according to the above scheme is as follows :—

Type of Course	*Designation or Number of Course*
Mathematical Physics and Applied Mathematics.	M.2, M.4, M.8, M.9, M.10, M.17, M.18, M.19, M.20, M.21, M.24.
Pure Mathematics ...	M.1, M.5, M.6, M.7, M.16, M.23.
Practical Mathematics and Statistics.	M.11, M.12, M.13, M.14, M.15, M.22.
Engineering Mathematics...	M.31 or M.32, M.33, M.34.

Laboratories, Drawing Office, Computing Bureau and Library.

The Mechanics Laboratory and workshop in the department are used for the systematic experimental study of the dynamical principles that underlie the theoretical treatment of Applied Mathematics.

The Statistical Laboratory, in the same way, is used to record, tabulate and analyse data accumulated by the student and to underline, by experiment, statistical principles and theorems on probability. It is also used as a mathematical laboratory for instruction in the use of computing machines, analysers, planimeters and other mechanical aids to computation.

The Computing Bureau is equipped with a wide variety of modern calculating and tabulating machinery, including an installation of Hollerith machines kindly loaned to the department by the British Tabulating Machine Company.

The Departmental Mathematical Library is available for the use of undergraduate and research students, who are permitted to borrow and consult books under certain conditions (*see* Regulations on Library Notice Board).

Associateship and Degree Courses in Mathematics.

The course for the A.R.C.S. Diploma and for the B.Sc. (Special) Degree in Mathematics extends over three Sessions, during which time the students attend lectures and exercise classes in Pure, Practical and Applied Mathematics, Mathematical Physics and Statistics, and carry out practical work in the laboratories. In addition, they attend certain courses in Physics, or Meteorology, or Geology in order to familiarise themselves with the methods of an experimental or of an observational science.

Normal Standard at Entry.

To qualify for entry an intending student must have passed at advanced level at the General Certificate Examination in Pure and Applied Mathematics. Physics and Chemistry, or in Pure Mathematics, Applied Mathematics and one other Science subject.* In addition every candidate for entry is expected to sit a special test examination.

The detailed nature of the courses is given below and exhibited in the annexed timetables.

First Year

In the first year, students in Mathematics must devote approximately six hours per week, on the average, to a course on Physics, Meteorology, or some other subject approved both by the head of the corresponding department and by the head of the department of

* Students accepted for entry will receive a note regarding special reading to be undertaken in preparation for the commencement of the autumn term.

Mathematics. The remainder of the work will relate to Pure and Applied Mathematics, Mechanics, Mathematical Statistics and Computation.

(i) *First Half-Session :—*

Pure Mathematics—M.7, M.16.
Applied Mathematics—M.9.
Statistics and Practical Mathematics—M.11, M.12, M.14.
Statistics Laboratory.
Physics.

(ii) *Second Half-Session :—*

Pure Mathematics—M.16 (continued).
Applied Mathematics—M.8, M.10.
Practical Mathematics—M.13, M.14 (continued).
Physics or Meteorology.

Second Year

This year is devoted entirely to mathematics alone, covering advanced mechanics, electricity, hydrodynamics, electro-magnetic theory, thermodynamics, kinetic theory of gases, relativity, statistical mechanics, quantum theory, mathematical statistics, pure mathematics, and practical mathematics.

(i) *First Half-Session :—*

Pure Mathematics—M.23.
Applied Mathematics and Mathematical Physics—M.17, M.18.

(ii) *Second Half-Session :—*

Pure Mathematics—M.23 (continued).
Applied Mathematics and Mathematical Physics—M.19, M.20, M.21.
Statistics—M.22.
Practical Mathematics—M.14.

Third Year

(i) *First Half-Session :—*

Applied Mathematics and Mathematical Physics—M.20, M.21 (continued).
Statistics—M.22 (continued).

(ii) *Second Half-Session :—*

This period will be devoted to special reading and/or attendance at advanced courses on technical, historical, or methodological topics. The student will select his own topic from a wide range offered to him and will be guided in his reading. He will be expected to produce a dissertation on the chosen subject and/or sit the Essay Paper in June.

Syllabuses.

M.1. Pure Mathematics. (*Intermediate Course.*)

(i) *Algebra.*—Real numbers ; identities, equalities, inequalities ; indices, logarithms ; induction ; polynomials, remainder theorem ;

elementary theory of equations ; partial fractions ; curve sketching ; complex numbers ; finite series, sequences, limits, infinite series ; binomial theorem ; exponential and logarithmic functions.

(ii) *Trigonometry*.—The circular functions, addition theorems, trigonometrical relations and equations ; solution of triangles.

(iii) *Co-ordinate Geometry*.—Straight line, circle, conics ; loci ; tangents, normals. Elementary three-dimensional geometry ; planes, straight lines, spheres.

(iv) *Differential and Integral Calculus*.—Derivatives of simple functions of one variable ; products and quotients ; logarithmic differentiation ; stationary values ; integration of rational and simple trigonometric functions.

(v) *Practical Mathematics*.—Graphical and numerical solution of equations ; graphical differentiation and integration ; nomograms ; elements of finite differences.

M.2. Applied Mathematics. (*Intermediate Course.*)

(i) *Dynamics*.—Kinematics of a particle ; velocities as vectors ; angular velocity, circular motion ; acceleration ; projectiles ; harmonic motion. Mass, momentum, force, kinetic and potential energy, impulse and impact, work and horse-power, frictional resistance. Method of dimensions. Introduction to rigid dynamics ; angular momentum, energy of rotation ; moments of inertia.

(ii) *Statics*.—Analytical plane statics ; composition and resolution of forces ; moments, couples ; equilibrium. Friction. Mass-centres : stability of equilibrium ; shearing force, bending moments ; stress, strain, Hooke's law, moduli of elasticity, Poisson's ratio. Hydrostatic pressure ; pressure on plane areas and curved surfaces ; floating bodies.

(iii) *Graphical Statics*.—Graphical representation of forces ; resultants ; link polygon ; frameworks ; Bow's notation and method of sections ; shearing forces, bending moments. Mass centres, moments of inertia, centres of pressure.

(iv) *Statistics and Probability*.—Prsentation of statistical data ; frequency tables, histograms ; mean and variance. Elements of probability. The binomial and normal distributions ; elementary sampling theory ; standard error ; significance.

(v) *Mechanics Laboratory*.—A course of experimental work designed to illustrate the principles of mechanics.

M.4. Applied Mathematics. (*For Students of Mining, Metallurgy and Oil Technology.*)

(i) *Mechanics*.—Dynamics of a particle ; mass, momentum, force, work, energy, power. Dynamics of rigid bodies rotating about a fixed axis ; moments of inertia. Harmonic motion. Simple machines ; hydraulic press. Friction. Governors, motion of crank and piston, power transmission, safety valves. Hydrostatics.

(ii) *Strength of materials*.—Stress, strain, Hooke's Law, Poisson's ratio, torsion, shear. Bending of beams, struts under axial loads ; rotation of shafts ; helical springs ; boilers.

(iii) *Statistics.*—Frequency distributions, histograms ; mean and variance ; least squares. Applications.

(iv) *Graphical and numerical methods.*—Graphical differentiation and integration ; mass centres, moments of inertia, centres of pressure : approximate methods for the solution of equations ; nomograms.

M.5. Pure and Applied Mathematics. (*For Students of Chemistry.*)

A course on algebra, calculus and differential equations with special applications to dynamics and theoretical physics, and physical chemistry.

M.6. Pure Mathematics. (*For Students of Physics.*)

Limits. Infinite sequences. Continuity. Differentiation. Inequalities. Exponential and logarithmic functions. Maclaurin and Cauchy forms of first mean value theorem. Leibnitz' theorem. Total differentials, partial differentiation. Transformation of variables. Laplace's operator in cylindrical and spherical polar co-ordinates. Euler's theorem. Taylor's theorem. Maxima and minima of functions of one variable. L'Hopital's rules. Taylor's theorem for two or more variables. Undetermined multipliers.

Elementary integration. Partial fractions. Definite integrals. Reduction formulae. Infinite integrals. Comparison tests. Mean value theorems for integrals. Frullani's theorem. Differentiation under the integral sign.

Arithmetic mean—geometric mean and Cauchy's inequalities. Elementary theory of determinants and matrices. Systems of linear algebraic equations.

Construction of ordinary differential equations. Graphical treatment of first order equation. Solution of special forms ; electrical applications.

The linear differential equation. The linear equation with constant coefficients ; operational methods. Resonance. Simultaneous differential equations. Differential equations of first order ; exact equations ; integrating factors. Linear equations of the second order ; normal forms. Solution in series.

Partial differential equations of the first and second orders ; boundary conditions. Partial differential equations with constant coefficients. Fourier's method. Complex variable applied to Laplace's equation.

Differential geometry of plane curves. Orthogonal systems of curves. Curvature ; the intrinsic equation of a curve.

Co-ordinate geometry of three dimensions. The line, plane and sphere. Properties of quadric surfaces. Simple ruled surfaces and surfaces of revolution. Partial differential equations or systems of surfaces.

M.7. Problem Class.

M.8. Mathematical Physics.

(i) *Vector Calculus.*—Line and surface integrals, potential functions, gradient, divergence and curl.

(ii) *Electrostatics.*—Inverse square law ; Gauss' Theorem, Laplace's and Poisson's equations ; equipotentials and lines of force ; conductors and dielectrics ; method of images. Potential energy ; Green's theorem, uniqueness theorems.

(iii) *Magnetostatics.*—Magnetic dipoles ; permanent and induced magnetism ; magnetic intensity and induction, permeability ; terrestrial magnetism, magnetic shells.

(iv) *Electromagnetism.*—Magnetic field of current circuit, Ampere's circuital relation ; Faraday's law of induction ; coefficients of self and mutual induction. Currents in linear circuits and in continuous media. Maxwell's equations.

M.9. Theoretical Mechanics.

(i) *Vector Methods.*—Position vectors, line vectors and free vectors ; unit vectors ; vector addition ; scalar and vector products ; vector area ; scalar derivative of vector function of a scalar (time) ; vector gradient of scalar function of a vector (position).

(ii) *Kinematics of Two-Dimensional Systems.*—Kinematics of particles and rigid bodies in two dimensions ; instantaneous centre.

(iii) *Mass Distributions.*—Centres of mass and moments of inertia of standard configurations ; quadratic moments of two-dimensional systems.

(iv) *Systems of Forces.*—Concurrent forces ; parallel forces ; couples ; vector moments ; elements of the theory of the equilibrium of a system of forces.

(v) *Particle Dynamics.*—Newton's laws of motion ; principle of linear momentum for a system of two particles ; kinetic energy ; elementary theory of collisons of fundamental particles.

(vi) *Potential Energy and Equilibrium of Systems of Particles and Fluids.*—Conservative fields of force ; gravitational attraction and potential ; equilibrium theory of fluids ; virtual work ; conservation of energy ; stability of equilibrium.

(vii) *Dynamics of Systems of Particles.*—Principles of linear and angular momentum ; motion of centre of mass and motion relative to centre of mass ; König's theorem on kinetic energy ; applications to rigid body in two-dimensional motion ; impulsive motion.

M.10. Theoretical Dynamics.

Theory of orbits, including simple applications to astronomy and physics ; dissipative forces and elementary theory of oscillations ; Lagrange's equations ; theory of small vibrations and normal modes ; Hamilton's equations ; principle of least action.

M.11. Statistics.

Histograms, cumulative curves ; probability paper ; mean, median, mode, standard deviation. Variance, covariance, and correlation coefficient. Laws of probability. Binomial, normal and Poisson distributions. Least squares. Elementary tests of significance.

M.12. Numerical Methods.

Principles of computation and tabulation of functions. Elements of finite differences. Interpolation formulæ of Lagrange, Gregory-Newton, Bessel, Gauss and Everett. Numerical estimation of differential coefficients by difference methods. Simpson, Milne, Euler-Maclaurin, Gauss and other methods of approximate integration.

Sketching contours ; nomograms ; curve tracing ; Newton's diagram. Numerical solution of algebraic and transcendental equations by successive approximation. Solution of difference equations, with applications.

M.13. Practical Mathematics.

Methods of stressing pin and stiff-jointed frameworks ; statical methods for simple frames ; strain-energy methods for redundant frames ; application of the relaxation method.

Development of the relaxation method ; solution of simultaneous linear algebraic equations ; numerical solutions of ordinary differential equations ; numerical solutions of Laplace's and Poisson's partial differential equations.

M.14. Practical Differential Equations.

Differential equations of first order considered graphically; the isoclinal system, properties and use ; cusp and envelope loci. Graphical solution of second order equations. Numerical solution of first and second order equations by finite differences. Picard's method. Successive approximations ; convergence ; boundary conditions. Higher order equations ; systems of simultaneous differential equations ; physical and dynamical applications.

Characteristic numbers and characteristic functions of a differential equation of the second order ; orthogonal functions, expansion theorems ; Rayleigh's principle. Differential equations for loaded strut and whirling shaft. Numerical studies of Fourier, Bessel, Legendre and elliptic-cylinder functions ; Green's function.

Practical Fourier analysis 12 and 24 ordinate methods, probable error of coefficients ; harmonic analysers.

Partial differential equations ; Laplace's and Poisson's equation in two dimensions ; applications to conduction of heat, fluid motion and vibration of continuous media. Periodogram analysis. Practical solution of integral equations.

M.15. Industrial Statistics.

Methods of recording, tabulating and summarising data. Properties of means, variance and covariance. Laws of probability. Theory and practice of control charts. Estimation of tolerances. Arrangement of assembly work. Design and analysis of industrial experiments.

M.16. Pure Mathematics.

(i) Analytical geometry of plane curves ; systems of plane curves, envelopes and orthogonal trajectories. Co-ordinate geometry of three dimensions ; quadric surfaces.

(ii) The elements of the theory of a complex variable ; conformal transformation.

(iii) Analytical geometry of surfaces ; one-parameter and two-parameter systems of surfaces and their envelopes ; ruled surfaces and developables.

Curves in space : vector representation. Parametric representation of standard surfaces ; co-ordinate networks. The first fundamental form—isometric and conformal representation.

The second fundamental form ; asymptotic lines, principal curvatures and lines of curvature ; specific curvature.

Geodesics : surfaces of constant specific curvature ; applications to non-Euclidean geometry and problems of geometry in general.

(iv) Functions of a complex variable ; complex integration ; theory of residues. Expansion of a function, Taylor's, Laurent's and Mittag-Leffler's theorems.

The solution of linear differential equations by Frobenius' method.

(v) The theory of infinite series and applications.

M.17. Theoretical Dynamics and Elasticity.

(i) Moving axes and particle dynamics ; kinematics of rigid bodies ; systems of line-vectors ; mass-systems and inertia tensors ; dynamics of spinning bodies ; Hamiltonian dynamics.

(ii) Cartesian tensors ; analysis of stress and strain ; stress-strain relations and the elastic constants ; equations of equilibrium and motion ; strain energy ; solution of simple problems, such as thick cylinders and spheres, torsion, bending and stretching of plates ; Airy stress function and simple two-dimensional problems.

M.18. Hydrodynamics.

(i) Dimensional theory ; dynamical similarity ; Reynolds' number.

(ii) Equations of motion of an inviscid fluid ; flow, circulation ; impulsive motion. Two-dimensional flow ; irrotational motion ; methods of conformal transformation, Joukowski transformation, Blasius' Theorem, Stokes' current function ; rotational motion and vorticity ; persistance of vorticity ; interaction of vortices, Karman vortex street.

(iii) Wave motion. Elements of the theory of sound.

(iv) Simple cases of flow of a viscous fluid.

M.19. Thermodynamics, Kinetic Theory of Gases, and Statistical Mechanics.

(i) The principles of thermodynamics and their applications. Equations of state ; phase equilibria ; the Gibbs' rule ; thermodynamics of magnetization ; reactions in the gaseous phase.

(ii) Elements of the kinetic theory of gases. The Boltzman H-Theorem ; the Maxwell distribution of velocities ; properties of rarified gases.

(iii) Elements of statistical mechanics. Liouville's theorem ; the partition function ; equipartition of energy ; classical radiation theory.

M.20. Quantum Mechanics.

Wave mechanics and the Schrödinger equation. The operator and matrix representation of dynamical variables. Methods of determining approximate solutions of the wave equation ; the variational method and the perturbation theory. Applications to problems of atomic and molecular structure.

M.21. Electromagnetic Field Theory and Special Relativity.

(i) Scalar and vector fields ; energy of electrostatic and magnetostatic fields ; Maxwell's equations ; electromagnetic waves and electromagnetic theory of light ; Poynting's theorem ; the electromagnetic potentials ; Kirchhoff's theorem ; plane electromagnetic waves in non-conducting and in conducting media ; reflection and refraction at a plane boundary ; elementary theory of rectangular and circular wave-guides ; the Hertzian oscillator ; scattering of light ; radiation pressure.

(ii) Foundations and applications of the Special Theory of Relativity.

M.22. Foundations of Statistical Theory.

Multivariate generalisation of properties of mean, variance and covariance. Markoff's theorem. Multivariate polynomial regressions. Multivariate normal distribution and derived distributions. Significance tests. Theory of estimation. Experimental arrangement and analysis.

M.23. Pure Mathematics.

(*a*) THEORY OF FUNCTIONS : PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS.

(i) Real numbers. Properties of continuous functions of a single real variable. Foundations of the differential calculus. Riemann integration. The convergence of real integrals.

(ii) Functions of two real variables. Implicit functions. Uniform convergence. Differentiation and integration of functions of two or more real variables. Double limit problems associated with infinite integrals.

(iii) Functions of a complex variable. The theory of residues. Rouché's theorem. Analytic continuation. Problems of uniform convergence. Conformal representation. The Schwarz-Christoffel transformation : introduction to doubly-periodic functions. The Gamma and Beta functions. Multiform functions ; the method of loop integrals.

(iv) Total differential equations ; first order partial differential equations. Standard forms linear partial differential equations with constant coefficients and two independent variables.

Transformation of $\nabla^2 V = 0$ in orthogonal curvilinear coordinates. Solution of simple boundary problems for $\nabla^2 V = 0$ and the occurrence of Legendre and Bessel functions in problems in mathematical physics.

(v) Use of Fourier Series in solving boundary problems. Formal generalisation to ortho-normal sets of functions. Fourier constants and approximation in the mean. Bessel's inequality. Completeness relation.

(vi) Weierstrass' approximation theorem for polynomials and trigonometrical functions. Fourier series for segmentally continuous $f'(x)$. Orthogonal functions generated by ordinary differential equations. Sturm-Liouville theory. Green's Function. Elementary potential theory. Application of conformal transformation.

(vii) The Fourier integral. Integral transforms. Fourier, Laplace and Bessel-Fourier transforms and their application to boundary problems in mathematical physics. Operational methods.

(viii) Second order linear partial differential equations in two independent variables. Elliptic, parabolic and hyperbolic types.

(ix) Canonical forms and characteristics. Riemann's method. Numerical integration of hyperbolic equations with Cauchy boundary conditions.

(x) Extensions to more independent variables. Kirchhoff's and Volterra's solutions of the wave equation.

(*b*) DETERMINANTS AND MATRICES.

Linear transformations. Fundamental operations on matrices. Diagonal and triangular matrices. Partitioning. Adjugate and inverse. Orthogonal matrices.

Rank and linear dependence. Reduction of a matrix to equivalent form. Decomposition into triangular factors. Solution of linear equations.

Cauchy and Laplace expansions of a determinant. The Binet-Cauchy Theorem. Compound matrices.

Linear, quadratic and bilinear forms. Reduction of quadratic forms to sums of squares.

The characteristic equation. Latent roots and vectors. Reduction to canonical form in the case of distinct latent roots.

M.24. Theoretical Dynamics. (*For Physics Students.*)

Theory of orbits, including simple applications to astronomy and physics ; motion in a resisting medium ; resonance ; special cases of non-linear vibrations ; moving axes ; Foucault's pendulum ; precessional motion.

Generalized co-ordinates ; Lagrange's equations and their applications ; theory of small linear vibrations and normal modes ; brief introduction to Hamilton's equations and the principle of least action.

M.25.

This covers a series of colloquia for third year students and research students and consists of lectures and free discussion on fundamental problems in mathematics.

Scheme of Examinations

for the Degree and Associateship in Mathematics.

Year		*Subjects of Examination*	*Number of Papers*	*Total per year*
1st	Feb.	Pure Mathematics (M.16)	1	
		Applied Mathematics (M.9) ...	1	
		Statistics and Practical Mathematics (M.11 and M.12) ...	1	
	June	Pure Mathematics (M.16)	1	
		Applied Mathematics (M.8) ...	1	
		Applied Mathematics (M.10) ...	1	
		Practical Mathematics (M.13 and M.14)	1	7
2nd	Feb.	Pure Mathematics (M.23)	1	
		Elasticity and Hydrodynamics (M.17, M.18)	1	
	June	Pure Mathematics (M.23)	1	
		Thermodynamics (M.19)	1	
		Problem Paper, Pure	1	
		Practical Mathematics (M.14) ...	1	6
3rd	Feb.	Quantum Theory (M.20), Electromagnetic Theory (M.21), Statistics (M.22) ...	2	
	June	Essay Paper ...	1	3
				16

Postgraduate Courses in Mathematics.

Students are accepted for research in topics that fall within the purview of any of the five sub-sections of the department. In general, such students will be expected to possess qualifications which would enable them to be registered as students for the degrees of M.Sc. or Ph.D. A student presenting a thesis of sufficient merit will be awarded the Diploma of the Imperial College (D.I.C.).

A selection of advanced lectures for research and postgraduate students is provided from among the following subjects :—

Electromagnetic waves ; theories of relativity ; non-linear mechanics ; statistical mechanics ; quantum theory ; elasticity ; motion of a viscous fluid ; motion of a compressible fluid ; theoretical geophysics and aero-physics.

Foundations of mathematics and of statistics ; the theory of probability ; the design of experiments ; industrial statistics for engineers ; advanced applied statistics.

Operational calculus ; finite differences ; calculus of variations ; matrix theory ; differential equations of mathematical physics ; integral equations ; general theory of linear differential equations ; Lie's theory of differential equations ; elliptic and automorphic functions and their applications ; algebraic geometry ; higher differential geometry.

Mathematics as an Ancillary Subject.

Students of other subjects, registered for the A.R.C.S., A.R.S.M. or A.C.G.I. Diplomas, attend courses in the Department of Mathematics as follows, at times indicated in their own departmental timetables, or in the general Intermediate timetable.

Intermediate Year :—

M.1, M.2.

First Post-Intermediate Year :—

Physics—M.6, M.8, M.9, M.11, M.12.
Chemistry—M.5.
Mining, Metallurgy, Oil Technology—M.4.
Engineering I (Aero., Mech., Civil, Elec.)—M.31.
Chemical Engineering I—M.32.

Students for the Degree or the Associateship in Physics are examined in the work of M.6, M.9, M.11, M.12. This covers the Mathematics required as subsidiary to Physics.

The examination in the work of M.4. ranks as an Intermediate examination in Applied Mathematics for students of Mining and Metallurgy.

Students in the departments of Mechanical, Civil or Electrical Engineering are examined in the work of M.31 in Part I of the examination for A.C.G.I. and B.Sc.(Eng.).

Students in the department of Chemical Engineering are examined in the work of M.32 in Part I of the examination for A.C.G.I. and B.Sc.(Eng.).

Second Post-Intermediate Year :—

Physics—M.24.
Engineering II (Aero., Mech., Civil, Elec. and Chem.)—M.33.

Students in the departments of Mechanical, Civil and Electrical Engineering are examined in the work of M.33 in Part II of the A.C.G.I. and B.Sc.(Eng.) examination.

Students in the department of Chemical Engineering are examined in the work of M.32 and M.33 in Part I of the A.C.G.I. and B.Sc. (Eng.) (Chem. Eng.) examination at the end of their second year.

Syllabus of Courses in Mathematics for A.C.G.I. and B.Sc.(Eng.).

First Year :—

M.31. (*For students in the departments of Aeronautical, Mechanical, Civil and Electrical Engineering.*)

Expansion in series ; hyperbolic functions ; technique of integration ; definite integrals with applications and approximate numerical evaluation ; partial differentiation ; approximate solution of numerical equations ; curvature of plane curves ; complex quantities.

Dynamics of a particle and of a rigid body about a fixed axis or in general plane motion ; resisted motion ; work and energy ; momentum and moment of momentum ; impulsive motion ; elastic impact.

Solution of first order differential equations by separation of variables and of linear equations with constant coefficients by operator methods ; applications to dynamics including elementary vibrating systems.

M.32. (*For students in the department of Chemical Engineering.*)

The subjects of the first two paragraphs of M.31 together with : Multiple integrals ; co-ordinate geometry of the straight line, plane and sphere ; chemical problems involving calculus.

Second Year :—

M.33. (*For students in the departments of Aeronautical, Mechanical, Civil, Electrical or Chemical Engineering.*)

First and second order differential equations integrable by quadratures ; linear differential equations with constant coefficients ; homogeneous and simultaneous linear differential equations with constant coefficients ; general solution in series ; numerical and graphical methods of approximate integration ; simple partial differential equations.

Fourier series and numerical harmonic analysis ; multiple integrals ; elementary functions of a complex variable ; elements of statistics.

Applications to bending of struts and ties and to vibrations, together with one of sections (*a*), (*b*) or (*c*) below :—

(*a*) One-dimensional heat conduction, steady heat flow, hydrodynamics, rotation of shafts. (For students in the departments of Aeronautical, Mechanical and Civil Engineering.)

(*b*) Differential equations for current and voltage in electric circuits, and in transmission lines and their solution in simple cases ; application of conjugate functions to potential problems. (For students in the department of Electrical Engineering.)

(*c*) One-dimensional heat conduction. (For students in the department of Chemical Engineering.)

M.34. (*A general mathematical course mainly for postgraduate students.*)

Operational methods based on Laplace transform ; Heaviside unit and related functions ; Duhamel integrals ; Factorial, Error and simple Bessel functions ; Wave, heat conduction and transmission line partial differential equations.

Partial differentiation of functions of several variables ; functions defined by integrals, Line integrals, Green's theorem, divergence and curl.

Functions of a complex variable ; conformal transformations ; contour integration.

Laplace transform inversion theorem ; Fourier integral.

M.35. (*A mathematical course mainly for Third-Year Electrical Engineering students.*)

Determinants and matrices ; solution of simultaneous linear equations ; use of Laplace transform to solve ordinary and partial differential equations with constant coefficients ; applications

to multi-mesh electric networks, line problems, etc. ; Gamma, Error and Bessel functions ; Functions of a complex variable ; contour integrals ; Inversion theorem for Laplace transforms ; Probability and Statistics.

Postgraduate Courses in Engineering Mathematics.

In addition to the above a series of shorter courses in mathematics with special reference to engineering applications are conducted primarily for those students of engineering subjects who are in their third year, or for postgraduate engineering students. They are subject to modification from year to year and will treat such topics as :—

Vector ideas and formulae ; theory of vibrations ; relaxation methods ; elasticity ; elementary statistics, including significant tests, least squares estimates and curve fitting.

The postgraduate courses listed on p. 198 are also open to postgraduate Engineering students.

MATHEMATICS

FIRST YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Pure Mathematics M.16.	Pure Mathematics M.16.	Mechanics M.9.	Pure Mathematics M.16.	Mechanics M.9.
11–12.	Pure Mathematics M.16.	Pure Mathematics M.16.	Mechanics M.9.	Pure Mathematics M.16.	Mechanics M.9.
12–1.	Practical Mathematics M.14.	Physics. P.10.	Numerical Methods M.12.	Pure Mathematics M.16.	Pure Mathematics M.16.
2–3.	Numerical Methods M.12.	Pure Mathematics M.7.	Physics P.10.	Pure Mathematics M.16.	Pure Mathematics M.16.
3–4.	Practical Mathematics M.14.			Statistics M.11.	Pure Mathematics M.16.
4–5.	Physics. P.10.			Statistics M.11.	

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Mechanics M.10.	Mathematical Physics M.8.	Mathematical Physics M.8.	Physics or Meteorology	
11–12.	Mechanics M.10.	Mathematical Physics M.8.	Mathematical Physics M.8.		
12–1.	Mechanics M.10.	Physics or Meteorology	Pure Mathematics M.16.	Physics P.10.	Pure Mathematics M.16.
2–3.	Pure Mathematics M.16.	Pure Mathematics M.16.		Practical Mathematics M.14.	Pure Mathematics M.16.
3–4.	Practical Mathematics M.13.	Practical Mathematics M.14.		Practical Mathematics M.14.	Pure Mathematics M.16.
4–5.	Practical Mathematics M.13.	Practical Mathematics M.14.		Pure Mathematics M.16.	

MATHEMATICS

SECOND YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Elasticity M.17.	Hydro-dynamics M.18.	Hydro-dynamics M.18.	Theoretical Dynamics M.17.	Elasticity M.17.
11–12.	Elasticity M.17.	Pure Mathematics M.23.	Hydro-dynamics M.18.	Theoretical Dynamics M.17.	Pure Mathematics M.23.
12–1.	Pure Mathematics M.23.	Pure Mathematics M.23.	Pure Mathematics M.23.	Pure Mathematics M.23.	Pure Mathematics M.23.
2–3.				Pure Mathematics M.23.	Pure Mathematics M.23.

SECOND YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Thermo-dynamics and Statistical Mechanics M.19.	Thermo-dynamics and Statistical Mechanics M.19.		Electro-magnetic Theory M.21.	Thermo-dynamics and Statistical Mechanics M.19.
11–12.	Thermo-dynamics and Statistical Mechanics M.19.	Pure Mathematics M.23.	Statistical Theory M.22.	Electro-magnetic Theory M.21.	Thermo-dynamics and Statistical Mechanics M.19.
12–1.	Pure Mathematics M.23.	Pure Mathematics M.23.	Statistical Theory M.22.	Pure Mathematics M.23.	Pure Mathematics M.23.
2–3.					Pure Mathematics M.23.
3–4.					
4–5.					

MATHEMATICS

THIRD YEAR—First Half-Session*

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Quantum Theory M.20.			Statistical Theory M.22.	Quantum Theory M.20.
11–12.	Quantum Theory M.20.			Statistical Theory M.22.	
12–1.	Special Relativity M.21.				
2–3.	Special Relativity M.21.				
3–4.					
4–5.					

* Certain post-graduate courses of lectures are open to third-year students.

DEPARTMENT OF METALLURGY

This department is located on the ground floor and upper ground floor of the Royal School of Mines building in Prince Consort Road. It provides the following accommodation :—

(1) The Analytical Laboratories for wet and fire assaying and for general metallurgical analysis, equipped with gas, coke and electric furnaces, balance rooms, etc. There are also small laboratories for special analytical procedures, including spectrographic and other physico-chemical methods of analysis.

(2) Metallographical Laboratories equipped with hand microscopes, photo-micrographic apparatus, dark rooms, polishing rooms, heat-treatment furnaces, etc.

(3) The Bessemer Laboratory containing re-heating furnaces and machines for hot and cold working by hammering and pressing and a Foundry equipped with gas, oil and high-frequency electric furnaces. Practical instruction in Mineral Dressing, under the direction of the Professor of Mining, is also given in this laboratory.

(4) A Welding Laboratory equipped for gas and arc welding, brazing and flame cutting.

(5) A Pyrometry Laboratory, with gas and electric furnaces, indicating and recording pyrometers, temperature controllers and apparatus for determining the physical constants of metals.

(6) A Mechanical Testing Laboratory, containing Tensile, Hardness, Impact and Fatigue Testing Machines.

(7) An X-ray Laboratory with the necessary cameras and other ancillary equipment.

(8) A Workshop, equipped with modern machine tools, where repairs to plant, machinery and apparatus can be carried out and where test samples can be machined and research equipment made.

(9) Various other rooms for advanced work and research.

(10) A Lecture Theatre, Class Room, Library, Store Room, Preparation Room and private offices.

Undergraduate and Postgraduate Courses.

Students taking the A.R.S.M. and B.Sc.(Eng.) Course in Metallurgy attend, during the first year, courses in other departments (*see* below).

During the second and third years, students take the specialised courses detailed below, embracing Metallurgy, Assaying, Electro-Metallurgy, Foundry Work, Mechanical Working and Testing of Metals and Alloys, Physical Metallurgy, Welding, Mineral Dressing, Fuel and Refractory Materials.

Metallurgy, in its various branches, is taught by means of lectures illustrated, as far as practicable, by means of diagrams, models and the metallurgical plant in the laboratories. Assaying, Metallurgical Analysis, Physical Metallurgy, Foundry Work, Mechanical Testing, Mineral Dressing and Welding are taught both by lectures and laboratory work.

The students in the second and third years are conducted by members of the staff on a tour of metallurgical works in Great Britain, and, occasionally, abroad. The tour is made during the Easter vacation and lasts about two weeks. Visits are also made to works in and near London during the terms.

In order to qualify for the A.R.S.M. in Metallurgy, students must have completed a minimum of twelve weeks' practical experience in works, which must normally be carried out during the last two summer vacations of the Metallurgy course.

Second and third Year Metallurgy students are charged a fee of £2 per annum for the loan of Metallurgy apparatus. Mining Geology and Mining students are charged 30*s*. in the year in which they work in the Metallurgical Laboratories.

Instruction in the Department is arranged in the following courses :—

(*a*) The Associateship course, lasting through the second and third Years for students studying for the A.R.S.M. and B.Sc. in Metallurgy.

(*b*) Courses arranged to suit the special requirements of students of the Mining Geology, Mining and Engineering Departments.

(*c*) Special courses of advanced study and research for students who have satisfactorily passed the Associateship course or who are similarly qualified.

(*d*) Occasional students are admitted to lecture and laboratory courses at the discretion of the Professor.

For details of the arrangements under which students working for the A.R.S.M. may spend their third year at the University of Sheffield, *see* pp. 30–31.

Associateship and Degree Course in Metallurgy.

Intermediate Year

Physics—P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Pure Mathematics—M.1.
Applied Mathematics—M.2.
Chemistry—C.021, C.041, C.042, C.047.
Principles of Machines, Min. 1.
Practical Geometry, Min. 1a.

First Year

Applied Mathematics—M.4.
Applied Mechanics—Min. 2.
Graphics—Min. 3.
Engineering Drawing and Design—Min. 4.
Geology and Mineralogy—G.1, G.2, G.3
Applied Electricity—E.E.7, E.E.8.
Physical Chemistry—C.113, C.115.
General Metallurgy—Met. 1.

SECOND YEAR

Mineral Dressing—Min. 10.
Non-Ferrous Extraction I—Met. 2.
Assaying—Met. 3.
Physical Metallurgy I—Met. 4.
Metallurgy of Iron and Steel—Met. 5.
Metallurgical Calculations—Met. 6.
Fuel Technology—Ch. E.2.
Refractory Materials—Ch.E.10.

THIRD YEAR

Mechanical Treatment—Met. 7.
Mechanical Testing and Heat Treatment—Met. 8.
Metallurgical Analysis—Met. 9.
Non-Ferrous Extraction II—Met. 10.
Physical Metallurgy II—Met. 11.
Furnace Drawing and Design—Met. 12.

Syllabuses

FIRST YEAR

Met.1. General Metallurgy.

Prof. Dannatt and Mr. Evans.

A series of lectures and tutorial classes occupying one hour per week throughout the session. This course gives a general survey of the whole field of metallurgy and is intended to emphasise the relationship existing between the various branches of the subject and the relevance of the subsidiary subjects studied in other Departments. Attention is given to the fundamental principles underlying the chief methods of metallurgical treatment and to certain subsidiary operations of general application.

SECOND YEAR

Met.2. Non-Ferrous Extraction Metallurgy I.

Prof. Dannatt and Mr. Yeoman.

A course of 40 lectures on the extraction and refining of the metals : aluminium, copper, gold, lead, silver and zinc.

Met.3. Assaying.

Mr. Yeoman, Mr. Evans, Mr. Pearse, and Mr. Selfe.

A course of lectures (30) and laboratory work covering : the assay, by " wet " and " fire " methods, of ores, metallurgical products and gold and silver bullion ; the analysis of the solutions obtained in the cyanide treatment of gold ores ; the examination of coal for its value as a fuel.

Similar courses are given to Mining Geology and Mining students.

Met.4. Physical Metallurgy I.

Dr. Fisher, Dr. Coles, Mr. Phillips, Mr. Thomas, and Dr. West.

An introductory course of lectures (40) and laboratory work on the principles and applications of physical metallurgy and metal physics, covering : the nature and properties of metals and alloys, equilibrium diagrams, pyrometry, thermal analysis, X-ray diffraction, microscopical examination, heat treatment and plastic deformation.

Met.5. Metallurgy of Iron and Steel.

Mr. Harris.

A course of 50 lectures on the smelting of iron ores in the blast furnace, the production of steel by the crucible, open-hearth, Bessemer and electric processes, and the casting and handling of steel ingots.

Met.6. Metallurgical Calculations.

Mr. Yeoman.

A course of lectures (40) and class work covering : Fuel : combustion, gasification, heat balances. Metallurgical operations : drying, roasting, smelting, refining, chemical and thermal balances.

Third Year

Met.7. Mechanical Treatment.

Mr. Tweeddale.

A course of 30 lectures dealing with rolling, forging, tube making, drawing, pressing and extrusion, and the effects of these treatments on the properties of metals and alloys.

Met.8. Mechanical Testing and Heat Treatment.

Mr. Tweeddale.

A course of lectures (30) and laboratory work covering : tensile, compression, impact, hardness and fatigue tests : methods of heat treatment, types of furnaces, and the effects of heat treatment on the properties of metals and alloys.

Met.9. Metallurgical Analysis.

Mr. Yeoman, Mr. Evans, Mr. Pearse, and Mr. Selfe.

A course of lectures (40) and laboratory work dealing with the partial and complete analysis of the ferrous and non-ferrous metals and alloys, ores, metallurgical products, fluxes, refractories, etc., to which reference is made in the other courses.

Met.10. Non-Ferrous Extraction II.

Prof. Dannatt, Mr. Yeoman, and Mr. Evans.

A course of 40 lectures dealing with the metallurgy of the less common metals, and including a more advanced treatment of the subjects of Met.2.

Met.11. Physical Metallurgy II.

Dr. Fisher and Appropriate Members of the Staff.

A course of advanced lectures and laboratory work on practical aspects of physical metallurgy, including: non-destructive testing, the behaviour of metals at high and low temperatures, gases in metals, internal stresses, corrosion, metallic wear, powder metallurgy, casting and welding. The preparation of technical reports and the critical study and discussion of scientific papers, form an important part of the course.

Met.12. Furnace Drawing and Design.

Mr. Yeoman.

A course of lectures and class work, at times to be notified, on the principles and details of design and construction of furnaces, together with instruction in the preparation of working drawings.

Special Courses for Students of Other Departments.

Met.13. Engineering Metallurgy.

Appropriate Members of the Staff.

Special courses of lectures (about 24) and practical work for students of Aeronautical, Chemical, Civil, Electrical and Mechanical Engineering. The courses deal mainly with the properties and uses of metals and alloys, foundry work, shaping processes and welding. They vary in detail to suit the particular requirements of the different classes of engineers.

Met.14. General Metallurgy for Mining Students.

Appropriate Members of the Staff.

A course of lectures and laboratory work similar to that given to Engineering students, together with about 20 lectures on the extraction and refining of gold, copper, nickel, zinc, lead, tin and aluminium.

Postgraduate Courses.

Students who have satisfactorily completed the course in Metallurgy for the Associateship of the Royal School of Mines, or who satisfy the authorities of the Imperial College that they have done equivalent work elsewhere, may proceed to higher work leading to the Diploma of the Imperial College (D.I.C.). This work may consist of (*a*) research work, or (*b*) a course of advanced study to meet individual needs.

Students and others who have completed a full course of instruction in Metallurgy may undertake original research work under the direction of the Professor. University graduates may, if approved, proceed to a higher Degree of the University of London.

METALLURGY

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—First Half-Session

(The Classes printed in italics will be taken in the Department of Mathematics, Royal College of Science.)

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Physical Chemistry Lecture C.113.	Engineering Lecture and Class Work Min. 2.	*Practical Mathematics Lecture M.4.*	Engineering Lecture and Class Work Min. 2.	*Elasticity Lecture M.4.*
11–12.	*Mechanics Lecture M.4.*		*Practical Mathematics Class Work M.4.*		*Elasticity Class Work M.4.*
12–1.	*Applied Mathematics Class Work M.4.*	Applied Electricity Lecture E.E.7.	Graphics and Engineering Drawing Min. 3 & 4.	Metallurgy Tutorial Met. 1.	Physical Chemistry Lecture C.113.
2–3.	Applied Electricity Laboratory E.E.8.	Graphics and Engineering Drawing Min. 3 & 4.	Graphics and Engineering Drawing Min. 3 & 4.	Economic Minerology Lecture G.1.	Graphics and Engineering Drawing Min. 3 & 4.
3–4.				Economic Mineralogy Laboratory G.2.	
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	*Applied Mathematics Lecture M.4.*	Geology Laboratory	Geology Laboratory	Geology Laboratory	Geology Laboratory
12–1.	*Applied Mathematics Class Work M.4.*	Physical Chemistry Lecture C.113.	Physical Chemistry Lecture C.113.	Applied Electricity Lecture E.E.7.	Physical Chemistry Lecture C.113.
2–3.	Applied Electricity Laboratory	Economic Mineralogy Lecture G.1.	Geology Laboratory G.2.	*Applied Mathematics Lecture M.4.*	Geology Laboratory G.2.
3–4.		Economic Mineralogy Laboratory G.2.		*Applied Mathematics Class Work M.4.*	
4–5.				Metallurgy Tutorial Met. 1.	

METALLURGY

SECOND YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday	Friday.
10–11.	Assaying Lecture Met. 3.	Non-Ferrous Extraction Lecture Met. 2.	Non-Ferrous Extraction Lecture Met. 2.	Non-Ferrous Extraction Lecture Met. 2.	Assaying Lecture Met. 3.
11–12.					
12–1.	Assay Laboratory	Mineral Dressing Laboratory	Assay Laboratory	Mineral Dressing Laboratory	Assay Laboratory
2–3.	Mineral Dressing Lecture Min. 10.	Mineral Dressing Lecture Min. 10.	Assay Laboratory	Mineral Dressing Lecture Min. 10.	Mineral Dressing Lecture Min. 10.
3–4.	Assay Laboratory	Mineral Dressing Laboratory		Mineral Dressing Laboratory	Assay Laboratory
4–5.					

SECOND YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Physical Metallurgy Lecture Met. 4.	Refractory Materials Lecture Ch.E.15.	Ferrous Metallurgy Lecture Met. 5.	Physical Metallurgy Lecture Met. 4.	Physical Metallurgy Lecture Met. 4.
11–12.	Physical Metallurgy Laboratory	Refractory Materials Laboratory	Physical Metallurgy Laboratory	Physical Metallurgy Laboratory	Physical Metallurgy Laboratory
12–1.				Met : Calculations Met. 6.	
2–3.	Ferrous Metallurgy Lecture Met. 5.	Fuel Technology Lecture Ch.E.2.	Physical Metallurgy Laboratory	Fuel Technology Lecture* Ch.E.2.	Ferrous Metallurgy Lecture Met. 5.
3–4.	Physical Metallurgy Laboratory	Refractory Materials Laboratory		Physical Metallurgy Laboratory	Physical Metallurgy Laboratory
4–5.					

* After Easter.

METALLURGY

THIRD YEAR—First Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Met : Analysis Laboratory	Met : Analysis Laboratory	Met : Analysis Laboratory	Met : Analysis Laboratory	Met : Analysis Laboratory
11–12.					
12–1.	Mechanical Treatment and Testing Lecture Met. 7, 8.	Met : Calculations Met. 6.	Mechanical Treatment and Testing Lecture Met. 7, 8.	Mechanical Treatment and Testing Lecture Met. 7, 8.	Mechanical Treatment and Testing Lecture Met. 7, 8.
2–3.	Met : Analysis Lecture Met. 9.	Met : Analysis Lecture Met. 9.	Met : Analysis Laboratory	Met : Analysis Lecture Met. 9.	Met : Analysis Laboratory
3–4.	Met : Analysis Laboratory	Met : Analysis Laboratory		Met : Analysis Laboratory	
4–5.					

THIRD YEAR—Second Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Metallurgy Laboratory	Physical Metallurgy Lecture Met. 11.	Physical Metallurgy Lecture Met. 11.	Non-Ferrous Extraction Lecture Met. 10.	Non-Ferrous Extraction Lecture Met. 10.
11–12.		Metallurgy Laboratory	Metallurgy Laboratory	Metallurgy Laboratory	Metallurgy Laboratory
12–1.	Non-Ferrous Extraction Lecture Met. 10.				
2–3.	Physical Metallurgy Lecture Met. 11.	Non-Ferrous Extraction Lecture Met. 10.	Metallurgy Laboratory	Metallurgy Laboratory	Physical Metallurgy Lecture Met. 11.
3–4.	Metallurgy Laboratory	Metallurgy Laboratory			Metallurgy Laboratory
4–5.					

DEPARTMENT OF METEOROLOGY

The Department of Meteorology is housed on the second and third floors of the Huxley Building, and is equipped with lecture rooms, laboratory, wind tunnel and workshop, and a library of meteorological books and journals.

The department also has experimental and observational facilities at the Biological Field Station at Silwood Park, and at Harlington.

Courses of Study.

Except for an introductory course of lectures given during the second half-session to first year students of Mathematics (*see* M.W.6 below), the work of the Department of Meteorology is essentially Postgraduate. Candidates who are admitted to the Department may apply for registration for the Diploma of the Imperial College (D.I.C.), and/or for the M.Sc., Ph.D., or D.Sc. Degree of the University of London. Students entering the department will be expected to have a Degree with high Honours, either in Physics (with subsidiary Mathematics), or in Mathematics, but preferably the former, and in all cases to have an adequate knowledge of both Physics and Mathematics.

Except in very special cases, all students will be required during their first year to attend courses of lectures in Physical and Dynamical Meteorology, Physical Climatology, Meteorological Measurements, Atmospheric Electricity, and the Statistical Treatment of Meteorological Observations. Lectures and Classwork in Synoptic Meteorology and the Principles of Weather Forecasting are an essential part of the training available in the department. The teaching of Meteorology in the department prepares students for appointments in Great Britain and in the Dominions and Colonies.

Facilities are available for experimental researches in the Physics of the Atmosphere, for the design and use of instruments for new types of meteorological observations and for research in synoptic meteorology. At the Biological Field Station at Silwood Park, facilities are available for investigations in micro-meteorology and especially in those aspects of the subject that have a bearing on entomology. At Harlington, adjacent to the College playing fields, a meteorological laboratory affords facilities for such observational researches as require an open unobstructed exposure. Field experimental researches may also be carried out in other localities, as dictated by the requirements of the researches.

Meteorology offers for research many problems which may be taken up profitably by students of Physics and Applied Mathematics.

The proximity of the Royal Meteorological Society at 49, Cromwell Road, S.W.7, enables students who become Student Members or Fellows of the Society to enjoy the facilities afforded by its Library, and by attendance at its meetings.

Applications for postgraduate places are normally considered in the first week in May. Candidates should therefore apply by 1st May, submitting full details of their first degree studies and examination results, and of any experience which they have had already

in scientific research or in meteorology. Candidates from overseas are recommended to send their applications as early as possible, but in no case later than 1st May.

The following courses of lectures will be given :—

NOTE.—Some preliminary reading of descriptive meteorology is desirable before embarking on the course M.W.1-5 below.

M.W.1. Physical and Dynamical Meteorology.

M.W.2. Meteorological Measurements.

M.W.3. Atmospheric Electricity.

M.W.4. A course of lectures and class-work on Synoptic Meteorology (Tropical and Extra-tropical), including the analysis of synoptic charts and their use for weather forecasting.

M.W.5. A short course of lectures on the Wider Aspects of Physical Climatology.

M.W.6. An introductory course of lectures, intended primarily for first year students of Mathematics, designed to emphasise the physical aspects of the subject, to be taken as an optional alternative to Physics during the second half-session.

M.W.7. Colloquia for free discussion of fundamental problems in meteorology held in the department on alternate Tuesdays during the first two terms of the session.

M.W.8. Meetings for the discussion of recent contributions to Meteorology on occasional Monday afternoons during the first two terms of the session, are arranged by the Meteorological Office, Kingsway, W.C.2, and students may attend these discussions by kind permission of the Director of the Meteorological Office.

DEPARTMENT OF MINING

The work of this Department is carried on in the Royal School of Mines in Prince Consort Road. The Engineering and Surveying drawing offices occupy the west wing on the first floor of the building, while lecture theatres, research and class rooms, departmental library, and offices are on the north side fronting Prince Consort Road.

The Bessemer Laboratory of the Royal School of Mines is a separate building situated on the South side of the main Building and houses a Mineral Dressing plant equipped for batch testing of ores by standard methods with standard control checking techniques. In addition, there is a pilot plant capable of continuously treating ore by jigging, tabling and cyanidation. Pilot-scale flotation plant is being installed.

The students are taught to use representative testing appliances and to make fundamental investigations of simple ores, checking their work by rapid panning, assay and micro-methods.

Provision is also made to enable fundamental as well as industrial research on ore dressing problems to be carried out and special apparatus is available for this purpose.

In one of the central bays of this laboratory have been placed gas, oil and petrol engines and the hydraulic machinery in connection with the second year instruction in Applied Mechanics. The arrangements are such that the gas engine may be run either on town gas or on gas made in a small " suction " gas-producer plant which forms part of the equipment. Complete tests of indicated horse power and brake power can be made.

Small fans with individual electric motors and galleries enable a series of experiments to be carried out by students covering all the more common ventilation problems encountered in mines.

The teaching equipment in mining consists of diagrams, lantern slides, models and full scale machinery. Many important illustrations are drawn from the Bessemer Laboratory, where, for instance, different types of ore-bin doors, which can be used either underground or on surface, are installed, in addition to various kinds of pumps, air-compressors and electrical equipment.

Practical work in Mine Surveying is done at the Tywarnhale Mine, Porthtowan, Truro, Cornwall, during the Summer Term. The Duchy of Cornwall has granted the College permission to use a piece of land, and suitable buildings for accommodating the class are erected. In addition, the Duchy has provided for that part of the mine which is required for underground surveying to be kept open. Unusual opportunities are available there for gaining experience in the correlation of surface and underground surveys.

By kind permission of H.M. Office of Works the practical work in topographical surveying is carried out largely in Hyde Park.

Associateship and Degree Course in Mining.

Intermediate Year

Physics—P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Pure Mathematics—M.1.
Chemistry—C.021, C.041, C.042, C.047.
Applied Mathematics—M.2.
Principles of Machines—Min. 1.
Practical Geometry—Min. 1a.

First Year

Applied Mathematics and Elasticity of Materials—M.4.
Applied Mechanics—Min. 2.
Graphics—Min. 3.
Engineering Drawing and Design—Min. 4.
Geology and Mineralogy—G.1, G.2, G.3.
Applied Electricity—E.E.7, E.E.8.
Workshops, M.E.2.

Second Year

Power Generation and Transmission (non-electrical)—Min.8.
Materials and Structures—Min. 11.
Electrical Engineering—E.E.30.
Topographical Surveying—Min. 6.
Principles of Mining—Min. 5.
Mining Machinery—Min. 9.
Mining Geology (First Course)—G.20, G.21.
Physical Chemistry—C.113.
Subsidiary Non-Examination Subjects.

Third Year

Mine Surveying—Min. 7.
Mineral Dressing—Min. 10.
Metallurgy—Met. 14.
Assaying—Met. 3.
Mining Economics—Min. 12.

Students are recommended to attend a First-Aid class set up under the St. John Ambulance Association in the department, and a short elementary course in Tropical Hygiene, both of these classes taking place outside College hours.

In addition, students must have completed during the vacations, beginning with the first, a total of 720 hours' work for the most part underground. Proper notes must be made of this work, for which notes marks are allotted. A diary of the work done must also be kept on forms obtainable in the department, which should be signed by the manager or other responsible official of the particular mine. Diary and notes pertaining to the work done during any particular vacation must be handed to the Professor of Mining before May 1st of the succeeding session, when they will be examined and returned. Eventually for the Degree, all notes will again be required for marking at the concluding examination in the last half-session.

For intermediate year Mining students (and any other students interested) a preliminary series of lectures on the Elements of Mining may be given. Attendance at this series is recommended, as students will then have learned something of mining before presenting themselves at mines.

For students who have done sufficient practical work before coming to the College, a Thesis or Dissertation on a mining subject or field can, upon agreement with the Professor, be submitted in place of the ordinary mining notes.

No student may proceed to the final year who has not cleared off all the subjects of the first two years.

The position in the Finals List is determined from a summation and a consideration of the results obtained for all the subjects of the second and third years. Students must satisfy in all these subjects.

A Graduate or Associate in Mining secures exemption from two out of the five years of practical work otherwise necessary before a candidate is eligible to sit for the Colliery Managers' Examination under the Coal Mines Act, while, in addition, any practical work done during the course and approved by the Board of Examiners conducting that examination, secures further exemption. It also secures exemption from two out of the four years of practical surveying experience necessary to take the examination for the Surveyors' Certificate, this same exemption being also granted to any occasional student taking and passing satisfactorily the full Surveying and Mine Surveying courses.

A Graduate or Associate of the Royal School of Mines further secures exemption from four out of the six years of practical experience otherwise necessary before a candidate can be elected an Associate Member of the Institution of Mining and Metallurgy.

The Internal B.Sc. (Eng.) Degree in Mining of the University of London and/or the Associateship in Mining carries with it exemption from Sections A and B of the Associateship Membership Examination of the Institution of Civil Engineers.

Min.1. Principles of Machines.

Mr. Jennings.

Syllabus.—Kinematics. Relative movement of machine links. Instantaneous axis ; centrodes. Velocity and acceleration images for complete machines. Transmission of circular motion : by means of belts, by means of toothed gearing. Wheel trains. Epicyclic trains.

Teeth of wheels ; cycloidal and involute teeth ; bevel gearing.

Conversion of circular motion into reciprocating motion ; crank and connecting rod mechanisms ; quick return motions. Cams.

Conversion of reciprocating motion into circular motion ; the direct acting engine ; the oscillating engine ; the rotary engine. Diagrams of crank effort.

General linkwork ; the four bar mechanism.

Aggregate motions ; various mechanisms and contrivances.

Min.1a. Practical Geometry.

Mr. Jennings.

This course deals with the graphic representation of the forms and relative positions of objects in space, in such a manner that magnitudes can be measured from the drawings. Orthogonal projection ; planes of projection or of reference ; simple examples of projections and sections of polyhedra ; rectangular and polar co-ordinates of a point ; representation of planes, and problems on the straight line and plane ; plane and solid figures in given positions ; sections ; developments ; projections of curves and of figures bounded by curved surfaces ; the sphere, cone, and cylinder ; interpenetrations ; tangent planes ; surfaces in contact with one another ; metric projection ; the principles of perspective projection ; horizontal projection ; contours ; problems relating to earthworks ; road construction ; intervisibility ; map reading ; determination of cubic capacity of such irregularly shaped earthworks as ore dumps, embankments, cuttings ; spherical triangles.

Min.2. Applied Mechanics.

Dr. Davies and Mr. Jennings.

Syllabus :—*Hydraulics.*—Relevant physical properties of fluids. Modes of motion of a fluid ; critical velocity ; velocity head ; pressure head. Bernoulli's Theorem. Fluid friction. Losses in pipe flow. Flow in open channels. Methods of measuring the rate of flow of fluids ; relation between pressure drop and rate of flow. Standard orifices. Flow over weirs and notches. Use of models in studying flow ; principle of dynamical similarity ; corresponding speeds. Impact of jets. Water wheels and turbines.

Applied Heat.—The laws of thermodynamics and those of permanent gases ; characteristic equation of gases. General energy equation. Adiabatic and isothermal changes. The thermodynamics of various ideal cycles of operation ; ideal efficiencies. Properties of steam ; Callendar's tables and equations ; entropy ; construction and use of temperature-entropy charts and total-heat entropy charts. Flow of gases through orifices ; application of the laws to the discharge from steam nozzles and injectors.

Combustion of Fuels.—Outline of the kinetic theory of gases ; molal heat capacities ; calorific value, calorific intensity, and evaporative power, with examples on their determination. Air theoretically required for the combustion of solid, liquid, and gaseous fuels. Analysis of flue and exhaust gases for estimating air supplied.

The Steam Engine.—Expansive use of steam. Effects of clearance volume in a reciprocating engine on power developed and steam consumed. Indicator diagrams, actual and hypothetical. Factors in the design of a steam engine for given conditions. Types and advantages of various valves and valve gears. Indicators for high-speed and low-speed engines. Elementary Theory of the steam turbine.

The Internal Combustion Engine.—Types of gas-engines and gas producers. Oil-engines, cycles of operation and types. Governing of gas-engines and oil-engines.

Testing of Engines.—Brake horse-power; indicated horse-power. Thermal, mechanical, and relative efficiencies.

Min.3. Graphics.

Mr. Jennings.

Syllabus :—The uses of squared paper, in recording statistics, finding areas, averages, empirical formulæ, and solving equations. The graphic representation of formulæ on squared paper and logarithmic papers. Graphical Integration. The addition, subtraction, and scalar product of vectors. Relative motion. The vector polygon applied to find the resultant of a number of concurrent forces, such as the forces in the members of braced frames, roof principals, girders, cranes; or to the balancing of rotating masses. The link polygon; its use in finding the resultant of any system of coplaner forces, and the centre of area of any plane figure. Diagrams of shearing force and bending moment on beams. Graphical determination of moment of inertia of plane sections. Compounding simple harmonic motions. Valve diagrams. The best angle at entrance and exit for the blades, and the power developed, in turbines and water wheels. Determination of whole pressure and centre of pressure on any surface, from a knowledge of the intensity of pressure at various points on the surface. The construction of alignment charts. Deformation of framed structures.

Min.4. Engineering Drawing and Design.

Mr. Jennings.

The lectures in Machine Design will deal with the following :—

The rough sketch; the scale drawing, complete with sections, dimensions, and specifications; the tracing and reproduction of the scale drawings in quantity for distribution; various processes of reproduction; drawing office routine; filing of drawings; modifications; making the best use of available material.

The strength and proportions of such standard details as nuts, bolts, screws, keys, cotters, pins, belts and of welded parts.

The design of simple riveted joints, shafts, couplings, pipe lines, cyclinder covers, ties, struts, boiler stays, girders (simple or built up of sections of rolled iron or steel), wheels, and wheel teeth, etc.

In the Drawing Office the student will obtain practice in the use of instuments by the careful execution of a graduated series of tracings. He will make hand sketches and take dimensions of simple details of machines, complete pencil drawings from these sketches, dimension and section the drawings, make the tracing, and produce photographic prints.

The examples will be chosen from among details of engines; boilers; valves; pipes; and their connections; machine tools hydraulic and mining machinery.

Min.5. Mining Principles and Practice.

Mr. Richardson.

Mineral Deposits.—Types : lodes, beds, masses, surfacial masses, alluvial deposits. Shape, extent, features, irregularities, and faulting of deposits.

Prospecting.—Geological reconnaissance. Surface or manual prospecting ; geophysical or instrumental prospecting.

Boring.—Percussive and churn drilling ; rotative and core drilling. Bore-hole surveying. Underground drilling.

Explosives.—Nature ; characteristics ; classes and compositions. Fuses and detonators. Handling and storage. Charging and firing. Misfires.

Shot-hole Drilling.—Percussive drilling ; hand tools and manual drilling. Rock drills and machine drilling. Rotative drilling by hand and machine.

Breaking Ground.—By explosives ; by coal cutters ; by pneumatic picks ; by miscellaneous means ; and by caving under ground weight.

Support and Linings.—Ground pressure ; water pressure ; rock strength ; support and lining of vertical shafts, inclined shafts and roads, level roads, and working places. Set timbering, continuous walling, water-tight lining, supports in advance for running ground. Subsidence and shaft pillars.

Mine Development.—Type, location, size, and sinking of vertical shafts ; layout and making of incline shafts, slopes, slants, adits, shaft stations, pit bottoms, main crosscuts, main and district roads.

Face Development.—General layout of temporary roads to provide length of working face. Winzes and raises, subsidiary crosscuts, passes for mineral and filling. Straight-road development ; contour development. Amount of advance development.

Mining Methods.—Room mining ; room and pillar ; pillar and stall ; bord and pillar ; and longwall. Back stoping ; rill stoping ; flatback stoping ; sub-level stoping ; and underhand stoping. Pillar and stope mining ; transverse-stope, and longitudinal stope. Top slicing ; bottom slicing ; sub-level caving, and block caving.

Openpit Mining.—Hand-loading pits, with shaft, with incline, with ropeway, with level traction. Pits with mechanical shovel, with drag excavators, with bucket excavators ; and locomotive traction. Stripping methods.

Alluvial or Placer Mining.—Ground sluicing ; hydraulicking ; pump hydraulicking ; and dredging. Stripping methods, drift mining, and deep-lead mining.

Loading.—Direct loading by hand, by mechanical shovel, and by scraper ; conveyor loading ; chute loading, pass and chute loading.

Haulage.—Rails and track. Mine wagons. Use of hand tramming, animal traction, locomotive traction, mechanical haulage and conveyors. Brake planes and self-acting inclines.

Winding or Hoisting.—Headframes. Incline winding. Vertical winding and cages ; cage loading and unloading ; vertical skips. Ropes ; material, construction, lay, types, cappings, and attachments. Winding systems and winding methods.

Drainage.—Vertical distribution of underground water. Drainage measures on surface. Underground measures ; adits, and water stoppings. Precautions against irruptions of water underground. Pumps ; main types, auxiliary types. Sinking pumps and station pumps.

Illumination.—Naked and enclosed lights. Hand and cap lamps. Electric lighting. Safety lamps, electric and flame types. Lamp houses and organization.

Ventilation.—Noxious gases and dusts in mine air. Humidity. Explosive mixtures of air and gas ; testing for gas in mine air. Natural ventilation. Fan ventilation. Estimation and control of the necessary circulation ; resistance of air-ways ; ventilation districts, stoppings, regulators, crossings, etc. Anemometers, pressure gauges, and hygrometers. Coal dust and stone-dusting. Mine fires.

Accidents and Rescue.—Causes and rates of accidents. Treatment and transport of injured. Means for prevention. Rescue equipment and organization.

Health and Welfare.—Diseases associated with mining prevention and treatment. Change-houses and baths. Housing and education.

This course begins in October and continues throughout the Session. It is associated with 720 hours' practical work done at mines during vacations.

Min.6. Topographical Surveying.

Mr. Sheppard and Dr. Thomas.

About 45 lectures with office and field work (160 hours).

Measurement of Distances.—Use of chains and steel tapes. Measurement of base-lines. Surveys depending mainly on linear measurements. Auxiliary instruments employed.

Exploratory Surveying.—Use of hand instruments ; prismatic compass, box sextant, aneroid barometer and Abney level.

Traversing with Compass Mounted on Tripod.—Magnetic declination and its variations. Traversing with fixed and loose needle.

The Theodolite.—Construction, use, manipulation and adjustment of the transit theodolite.

Traversing with the Theodolite.—Independent and triangulation supported traversing. Plotting by protractor and by rectangular co-ordinates. Use of traverse tables. Adjustment of closing error.

Triangulation.—Measurement of base-lines ; simple triangulations ; complex systems with primary, secondary and tertiary orders ; satellite stations ; intersections and resections. Errors and their distribution.

Levelling.—Use and adjustment of levels ; levelling rods. Plotting of profiles. Special instruments and methods for precise levelling. Effect of earth's curvature and refraction in levelling over long distances. Trigonometrical levelling.

Tacheometric Surveying.—Tacheometer or stadia theodolite ; stadia rods. Contouring. Precise tacheometry.

Plane Tabling.—Simple and telescopic alidades. Beaman stadia arc. Application and adjustment of the range finder.

Geographic Position.—Determination of latitude, longitude and azimuth. Field astronomy and use of nautical almanac. Elements of geodesy.

Measurement of Areas and Volumes.—Computations, use of planimeter and computing scale. Measurement of excavations and dumps.

Aerial Surveying.—Elements of photogrammetry.

Setting Out.—Roads, railways, buildings, drainage and property boundaries.

Study of Errors.—Sources, classes, propagation and growth. Treatment of non-systematic errors by method of least squares.

Min.7. Mine Surveying.

Mr. Sheppard and Dr. Thomas.

40 lectures ; 450 hours' field and office work of which about 300 are spent on Tywarnhale Mine, Cornwall.

Surveying with Miners' Dial.—Manipulation, adjustment, and use of various types of dials.

The Mine Theodolite.—Transit theodolites with and without additional interchangeable side and top telescopes. Special centring appliances. The three-tripod system. The effect of errors of instrumental adjustments on the accuracy of underground surveys. Precise traversing for holing-through jobs. The more expeditious traversing methods for routine and periodic surveys. Connection of the mine triangulation with the geodetic triangulation.

Correlation of Underground and Surface Surveys.—Plumb-wiring in one vertical shaft, and in two vertical shafts, traversing inclined shafts ; and various combinations. Correlation by precise magnetic methods using orientation lines to correct for variation of magnetic declination and instrument errors.

Underground Levelling.—Use of the level ; underground levelling with the theodolite by horizontal sights or by vertical angles. Measuring the vertical depths of shafts.

Underground Setting-out.—Setting out a point having given co-ordinates ; giving and maintaining direction and gradients for

inclined shafts, slopes, levels ; consideration of the accuracy required for any given work. Setting out horizontal and vertical curves.

Stope and Face Surveying.—Use of Miners' dial, hanging compass with hanging clinometer, and Locke level for surveying excavations. Tape triangulation, radiation, traversing methods.

Borehole Surveying.—Construction and use of borehole survey instruments.

Mine Models.—Use of mine models ; methods of construction. Tri-dimensional maps.

Calculating Machines.—Uses and application to surveying calculations.

Min.8. Power Generation.

Dr. Davies.

Main Sources of Energy.—Energy available from fuels and the fall of water.

Fuels.—Solid, liquid, and gaseous fuels ; calorific value, general properties, sampling, testing, storage.

Steam Power.—Types of boilers ; mechanical and hand-stoking ; natural and mechanical draught ; pulverized-fuel firing ; oil firing. Auxiliaries and feed-water treatment. Economisers. Air heaters. High-pressure boilers and steam generators. Efficiency of steaming plant. Reciprocating steam engines ; steam turbines. Surface condensers ; jet condensers. Regenerative feed heating. Steam re-heating. Thermal efficiency; efficiency ratio. Steam accumulators ; utilization of Exhaust steam.

Gas Power.—Producers and gas production, with different types of fuels. Operation and control. Engines, types and choice for specific purposes. The gas turbine.

Oil Power.—Cycles of operation. Types of engines. Fuel pumps and atomisers. Injection systems. Cooling systems.

Water Power.—Conservation and storage ; site, rainfall and evaporation. Water channels and pipe-lines. Head-water control and accessories from dam to power house. Water turbine machinery. High and low head schemes.

General.—Economic merits and efficiencies of different power plants. Capital and operating costs. Governing, testing, care, and maintenance. Life depreciation and amortization. Power consumption on mines.

Note.—The above syllabus is treated from the practical aspect, taking illustrations as far as possible from mining practice, and is supplemented by actual tests on power plants in the City and Guilds College. A knowledge of the necessary thermodynamics and hydraulics is given in the first year.

Min.9. Mining Machinery.

Dr. Davies.

Machinery used in Primary Operations.—Rock drills, cutting and loading machines, conveyors.

Haulage Machinery.—Resistance and tractive effort; rope haulage; locomotive haulage. Coefficient of adhesion; limiting gradient. Trolley-wire, battery, Diesel and compressed-air locomotives.

Winding Machinery.—Winding systems for vertical and inclined shafts. Velocity, torque and power curves for complete winding cycles. Methods of balancing, electric winders, steam winders; methods of control, safety devices. Capital and operating costs.

Ventilating Machinery.—Air flow in shafts and roadways; centrifugal fans, axial flow fans. Fan characteristics and mine characteristics. Thermodynamics of natural ventilation. Fan testing.

Pumping Machinery.—Storage; pumping capacity and load-factor. Analysis and treatment of water. Flow in pipes; reciprocating, centrifugal and turbine pumps. Main shaft installations and sinking pumps.

Compressed-air machinery.—Theory of air-compressors and motors; reciprocating compressors, turbo-compressors and hydro-compressors; reciprocating and rotary air motors. Transmission of compressed air.

Mine Cooling Machinery.—Refrigeration and dehumidefication of mine air. Refrigerator cycles; vapour compression machines; air machines; coefficient of performance; positional efficiency; energy consumption and power. Typical mine installations.

Min.10. Mineral Dressing.

Mr. Pryor and Dr. Fleming.

Introductory.—Literature. Definitions. Place and purpose of Mineral Dressing in extraction metallurgy. Physical characteristics of ores exploited in treatment, including colour and lustre; density; surface properties; paramagnetism and conductivity. Crystal interlock and economic grinding mesh. Chemistry in ore pulps.

Amenability.—Simple field and laboratory tests of response to treatment of common ore minerals and their underlying principles.

Liberation.—Crushing, grinding and grading. Jaw, gyratory, cone and roll crushers; hammer mills, pendulums; stamps, road and ball mills. Crushing laws, theory and practice. Typical flowsheets. Commercial screens and classifiers.

Laboratory Sizing.—Laboratory screens; sedimentation; elutriation, turbidimetry, infrasizing. Laws of movement of solids in fluids. Sizing analysis. Microscopy of polished sections and

sands. Use of plaque, super-panner, heavy liquids. Interpretation of screen-and-assay analyses, and connexion with process control.

Concentration.—(*a*) *Gravity.* Washing, sorting. Application or rising, pulsating and horizontal currents in jigs, tables, vanners, etc. Heavy-media separation.

(*b*) *Flotation.* Principles. Applied surface-physics and surface-chemistry. Chemistry of process control. Types of machine, their place, application and maintenance. Types of circuit and ore treatments for simple, complex sulphides, oxide and economic earths. Agglomeration flotation.

(*c*) *Hydrometallurgy.* Machines used in cyanidation and similar processes. Control. Typical flowsheets combining cyanidation with tabling, flotation, etc.

(*d*) *Miscellaneous Methods.* Magnetic and electrostatic separation, theory and practice. Minor processes.

Coal Cleaning.—Rank ; types of coal. Fixed and free ash. Methods of cleaning and grading including de-dusting ; hand-sorting ; screening ; hydroclassification ; sink-float ; Baum and Rheo washing ; flotation ; wet and dry tabling. Washery slurries and water handling. Float and sink tests and their application to control.

Control.—Plant arrangement for various flow-sheets. Use of rougher-cleaner-scavenger combinations and circuit-closure for grade control. Construction, adaptation and reading of flow-sheets. Taking and reducing a sample and testing it. Automatic controls, weightometers, pH meters, density controllers, etc. Computation of efficiency criteria from assay returns. Balance between economic and technical factors in mill management.

Miscellaneous Plant.—Principles, types and operating control of pumps, thickeners, filters, and ancillary machines. Transport through the mill. Lay-out and design. Tailings disposal. Flow-sheets. General management and cost control.

Min.11. Materials and Structures.

Mr. Jennings.

Materials.—General considerations regarding working stress. Elastic limit. Dead-load and live-load stresses. Effect of repeated stress and of alternating stress. Factor of safety. Materials used in structural engineering ; specifications and tests. Loads and supports in structures. Limitation of weights and dimensions of members by transport and handling facilities. Quantities and costs.

Framed Structures.—Design of head-frames ; roof and bridge trusses ; trestles. Determination of stresses in the members. Counterbracing. Deformation of framed structures. Redundant frames.

Design of Tension Members.

Design of Compression Members.—Columns and struts. Theoretical formulas. Working formulas. Effect of eccentric loading.

Combined Direct and Bending Stresses.—Examples.

Riveted Work.—Grouping of rivets. Distribution of stress in eccentrically-loaded rivet connexions. Rules for rivet spacing.

Beams.—Relation between load-intensity, shearing-force, bending moment, slope, and deflection along a beam. Equivalent uniformly distributed loads for bending moments. Continuous beams. Determination and use of characteristic points. Pressure on supports. Yielding supports.

Beam sections. Moment of resistance. Section modulus. Use of Steel Makers' Handbooks.

Built-up beams. Plate girders. Hinged arches and rigid arches.

Structures in Timber and Steel.

Masonry Structures.—Stability. Chimneys.

Earth Pressure.—Retaining walls, foundations, bins.

Reinforced Concrete.—Approximate formulæ and calculations for columns and beams. Application to bins, floors, retaining walls. Pre-stressing of concrete.

Note.—The above syllabus is treated from the practical aspect, taking illustrations as far as possible from mining practice. A knowledge of the necessary graphic and analytic methods of calculation is given in the first year.

Min.12. Mining Economics (including Mine Sampling).

Mr. Richardson and Mr. Sheppard.

The Mineral Industry.—Importance to the community. Difference from other industries, and resemblances. Mineral reserves the basis of the industry.

Underground Sampling.—Pilot sampling, geological reconnaissance. Close sampling, nature of real samples and of mine samples. Groove or channel samples, pick samples, grab samples, popshot samples, and bulk samples. *Development Sampling.*—Purpose. Sampling of drifts, winzes and raises, crosscuts, and sill-floors. *Workingplace Sampling.*—Purpose, sampling from the solid, sampling of broken material.

Preparation of sample portion for Assay or Analysis.—Crushing, mixing, and dividing.

Computations for Probable Assay Value.—Averaging across widths, along lengths, around blocks, and of total reserves.

Tonnage.—Density determinations, and estimates of probable volume and tonnage.

Recording of Sampling Results.—Tickets, tags, books, charts, maps, mine models.

Reliability of Underground Sampling.—Chance errors, systematic errors, grade error by dilution with waste and by loss of rich fines. Effect of class of deposit on amount of sampling necessary. Extent and cost of underground sampling.

Independent Sampling.—Procedure and precautions. Prevention and detection of salting.

Borehole Sampling of Surfacial Rock Deposits.—Drills used. Treatment of sludge and core. Spacing of holes. Averaging. Reliability and cost.

Sampling of Alluvial Deposits.—Drills used. Measurement and treatment of the material recovered. Spacing of holes. Pitting. Averaging. Reliability and cost.

Sampling of Dumps, Heaps, and Parcels.—Volume, density, and weight determinations ; and sampling.

Mineral Reserves.—Classes : bored reserves ; developed or blocked-out reserves. Prospective extensions. Total underground costs in winning reserves.

Beneficiation of Reserves.—Percentage of mineral or metal made marketable. Cost of beneficiation.

Markets and Marketing.—Methods of sale ; schedules and tariffs. Contracts and specifications. Prices for products.

Property Valuation.—Probable annual value. Capitalized or present value. Incidence of the various factors in the computation.

Money Requirements.—Capital expenditure for the property, equipment, mine development, and working capital.

Financial Constitution of Mining Enterprises.—Joint Stock and Limited Liability companies. Company Capital and Shares. Loan Capital and Debentures. Working Capital. Nominal Capital and Intrinsic Capital. Properties held under royalties, leaseholds. Principal prescriptions of the Companies Act.

Annual Report.—Contents and purposes.

Financial Statements.—Balance Sheet. Operating or Working Account. Profit and Loss Account. Appropriation Account. Depreciation and Amortization. Critical examination of the financial position.

Book-keeping.—Principal and subsidiary books. Accounts and statistical books. Entries and postings. Balancing and closing accounts. *Store-keeping*.—Books, forms, and methods used for purchases, issues, and sales. *Time Sheets and Pay Sheets*.—Forms to suit different conditions of employment. *Distribution Sheets*.—Headed under the different mining operations, and under labour, stores and management. Cost accounting.

Labour.—Day work contract work, piece work, and bonus work.

Stores.—Mining stores ; prices and quotations ; regular and contract purchases ; miscellaneous purchases.

Management.—Duties and organization. Rationalization. Efficiency engineering. Time Studies. Standardization. Training of Labour. Standard of performance. Planning in advance. Supervision.

Legislation.—General principles of mining law and tenure of mineral property. Principal provisions of the Coal Mines Act, and the Metalliferous Mines Act.

Min.13. Tropical Hygiene.

A short course of six lectures upon the simple means of preserving health in the tropics, and desirable therefore for men going beyond towns and settled camps in tropical countries is given in the Mining Department towards the end of the second half-session, in the evening just after College hours. Attendance is open to all students of the College and, while not compulsory, is recommended.

Min.14. First Aid to the Injured.

Before Christmas a short course of six lectures followed by exercises is given in the Mining Department under the St. John Ambulance Association, finishing with an examination for certificates. This class takes place in the evening. Attendance is open to all students of the College at a fee of five shillings.

Min.15. Elementary Surveying.

Dr. Thomas.

Twenty lectures with office and field work including 2 weeks at Tywarnhale Mine, Cornwall (120 hours).

A course designed to meet the needs of Geophysics students and embracing chaining, levelling, exploratory surveying, plane tabling, compass and theodolite traversing, and tacheometric surveying.

Postgraduate Courses.

The Bessemer Laboratory is available and possesses the necessary equipment for research into problems concerned with ore dressing

MINING

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—First Half-Session

(The classes printed in italics will be taken in the Department of Mathematics, Royal College of Science.)

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Graphics Min. 3.	Engineering Lecture and Class Work Min. 2.	*Practical Mathematics Lecture M.4.*	Engineering Lecture and Class Work Min. 2.	*Elasticity Lecture M.4.*
11–12.	*Mechanics Lecture M.4.*		*Practical Mathematics Class Work M.4.*		*Elasticity Class Work M.4.*
12–1.	*Mechanics Class Work M.4.*	Applied Electricity Lecture E.E.7.	Graphics Min. 3.		Graphics Min. 3.
2–3.	Applied Electricity Laboratory E.E.8.	Engineering Drawing and Design Min. 4.	Engineering Drawing and Graphics Min. 3 & 4.	Economic Mineralogy Lecture G.1.	Engineering Drawing and Design Min. 4.
3–4.				Economic Mineralogy Laboratory G.2.	
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	*Applied Mathematics Lecture M.4.*	Geology Laboratory	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.
12–1.	*Applied Mathematics Class Work M.4.*	Applied Electricity Lecture E.E.7.			
2–3.	Applied Electricity Laboratory E.E.8.	Economic Mineralogy Lecture G.1.	Workshops M.E.2.	*Applied Mathematics Lecture M.4.*	Palæontology Lecture G.1.
3–4.		Economic Mineralogy Laboratory G.2.		Geology Laboratory G.2.	Palæontology Laboratory G.2.
4–5.					

MINING

SECOND YEAR—First Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Power Lecture Min. 8.	Surveying Min. 6.	Power Lecture Min. 8.	Surveying Min. 6.	Power Lecture Min. 8.
11–12.	Mining Lecture Min. 5.		Mining Lecture Min. 5.		Mining Lecture Min. 5.
12–1.	Mining Geology Lecture G.20, 21.		Mining Geology Lecture G.20, 21.		Mining Geology Lecture G.20, 21.
2–3.	Power Min. 8.	Surveying Min. 6.	Surveying Min. 6.	Surveying Min. 6.	Mining Min. 5.
3–4.					Colloquium
4–5.					

SECOND YEAR—Second Half-Session

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.
10–11.	Electrical Engineering E.E.30.	Mining Machinery Lecture Min. 9.	Electrical Enginerring E.E.30.	Mining Machinery Lecture Min. 9.	Mining Machinery Lecture Min. 9.
11–12.		Mining Lecture Min. 5.		Mining Lecture Min. 5.	Physical Chemistry C.113.
12–1.					
2–3.	Mining Machinery Min. 9.	Materials and Structures Min. 11.	Mining Laboratory	Materials and Structures Min. 11.	Colloquium
3–4.					
4–5.					

MINING

THIRD YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Assaying Lecture Met. 3.	Metallurgy Lecture Met. 14.	Metallurgy Lecture Met. 14.	Metallurgy Lecture Met. 14.	Assaying Lecture Met. 3.
11–12.	Mineral Dressing Laboratory Min. 10.	Assay Laboratory Met. 3.	Assay Laboratory Met. 3.	Assay Laboratory Met. 3.	Mineral Dressing Laboratory Min. 10.
12–1.					
2–3.	Mineral Dressing Lecture Min. 10.	Mineral Dressing Lecture Min. 10.	Assay Laboratory Met. 3.	Mineral Dressing Lecture Min. 10.	Mineral Dressing Lecture Min. 10.
3–4.	Mineral Dressing Laboratory Min. 10.	Assay Laboratory Met. 3.		Assay Laboratory Met. 3.	Mineral Dressing Laboratory Min. 10.
4–5.					

THIRD YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Mining Economics Lecture Min. 12.	Mining Economics Lecture Min. 12.	Mining Economics Lecture Min. 12.	Mining Economics Lecture Min. 12.	Mining Economics Lecture Min. 12.
11–12.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.
12–1.					
2–3.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.	Mine Surveying Min. 7.
3–4.					
4–5.					

Easter to Mid-May

Eight weeks' practical surveying at Tywarnhale Mine, Cornwall.

DEPARTMENT OF PHYSICS

(including Astrophysics, Technical Optics and Applied Geophysics.)

The Physics Department occupies the western half of the Royal College of Science building. It includes 6 large laboratories, 3 lecture theatres, and about 40 smaller rooms for instruction and research, of which several are specially fitted for particular purposes. In addition, there is a small observatory for astro-physical work, and workshops for the construction and repair of apparatus for a large variety of work, including optical work and work of precision.

The large advanced laboratory on the first floor accommodates the second and third year students.

Two large laboratories, on the first and top floors, respectively, are at present devoted to technical optics and first year work.

The elementary laboratory on the ground floor is capable of accommodating about 40 students.

Laboratories for astrophysics, geophysics and spectroscopy complete the list of main laboratories.

The large lecture theatre on the lower ground floor is capable of seating upwards of 150 students, and is well provided with arrangements for demonstration and projection required for experimental lectures. The lecture table itself is solidly founded, and insulated from the floor, so as to be adapted for the performance of delicate experiments if required. The small lecture theatre at the back is similarly fitted, and is capable of seating about 60 students. Adjoining the lecture theatres are store and preparation rooms for lecture apparatus.

The astrophysics lecture theatre, on the ground floor, normally accommodates about 40 students, but provision can be made for 60, if necessary.

The Department is equipped with two Van de Graaff high voltage generators. One is of the atmospheric type, capable of giving about 700,000 volts ; the other is of the high pressure type, capable of giving about 2,000,000 volts. These are used for accelerating ions for nuclear research.

The observatory is located in the open space behind the workshop. The principal instruments include a transit instrument and sidereal clock, for instruction in time observations, and a 6-in. equatorial on loan from the Royal Observatory, Greenwich.

The library of the Physics Department contains an adequate supply of recent and standard works on various branches of Physics. Journals and periodicals may be consulted here, and also in the library of the Science Museum, which adjoins the department.

Associateship and Degree Course in Physics.

Students proposing to take Physics courses are advised to acquire sufficient proficiency in Mathematics to ensure their following the lectures with ease. A knowledge of the elements of the calculus is highly desirable for courses in the Intermediate Year, and absolutely essential for those of later years.

In certain cases, as determined by the Professor of Physics, some of the time normally devoted to other subjects may be devoted to further work in Physics.

The examinations in Physics at the end of the courses will include practical work in the laboratory in addition to theoretical papers.

INTERMEDIATE YEAR

First Half-Session :—

Physics—P1, P.2, P.3, P.4, P.5, P.6, P.7, P.8.
Mathematics—M.1.

Second Half-Session :—

Chemistry—C.021, C.041, C.042, C.047.
Mathematics—M.2.

FIRST YEAR

First Half-Session :—

Mathematics—M.6, M.9, M.11, M.12.
Physics—P.11, P.12, P.13, P.15, P.24, P.26.

Second Half-Session :—

Mathematics—M.6, M.8.
Physics—P.11, P.12, P.13, P.14, P.15, P.24, P.26.

SECOND YEAR

Mathematics—M.24.
Physics—P.16, P.17, P.18, P.19, P.20, P.21, P.22, P.23, P.24, P.25, P.26.

THIRD YEAR

Physics—P.26, P.27, P.28.

Undergraduate Courses.

INTERMEDIATE YEAR

The Intermediate year courses in Physics consist of :—

(1) Elementary courses of experimental lectures in which the general principles of Physics are explained and illustrated ; combined with

(2) Class-work in which students are instructed in working out numerical exercises illustrating the subjects of the lectures ; and

(3) Systematic courses of practical training in the use of instruments and in the measurement of fundamental physical quantities.

An elementary knowledge of Mechanics and practical Mathematics is assumed in the Physics lectures and classes ; also a general acquaintance with the mechanical properties of matter, and with measurements of the simpler physical quantities.

P.1. Optics.

Mr. B. K. Johnson.

A course of about 10 lectures.

Syllabus :—LENSES.—Derivation of formulae ; sign convention.

DISPERSION.—Spectrum ; dispersive power ; infra-red and ultra-violet radiation ; the achromatic lens.

THE EYE.—Emmetropic, myopic and hypermetropic vision.

OPTICAL INSTRUMENTS.—Telescope ; microscope ; photographic lenses ; optical projection systems.

PHOTOMETRY.—Photometric principles and standards.

WAVE THEORY.—Velocity of propagation ; interference ; diffraction.

P.2. Astronomy.

Dr. R. W. B. Pearse.

A course of about 7 lectures.

P.3. Electricity and Magnetism.

Dr. Wynn-Williams.

A course of about 18 lectures.

Syllabus :—MAGNETISM.—Elementary theory of magnetism ; measurements ; magnetic properties of materials ; terrestrial magnetism.

ELECTROSTATICS.—Elementary electrostatic theory ; measurements ; machines.

CURRENT ELECTRICITY.—Law of current flow ; magnetic, thermal and chemical effects associated with a current ; measurements ; thermo-electricity ; electromagnetic induction.

P.4. General Physics and Sound.

Mrs. Brock.

A course of about 12 lectures.

Syllabus :—GENERAL PHYSICS.—Units and dimensions ; gravitation ; elasticity ; kinetic theory of gases ; surface tension ; viscosity.

SOUND.—General equation of wave motion ; velocity of transverse and longitudinal vibrations ; stationery vibrations ; measurement of velocity of sound in air ; beats ; Lissajous figures ; quality, pitch and intensity of sounds ; Doppler's principle.

P.5. Heat.

Mr. Garton.

A course of about 10 lectures.

Syllabus :—Thermometry ; thermal expansion ; calorimetry ; mechanical equivalent of heat ; properties of gases ; change of state ; refrigeration ; transference of heat.

P.6. Modern Physics.

Dr. Latham.

A course of about 9 lectures.

P.7. Classwork.

Mrs. Brock and the Demonstrators.

Exercises on the subjects of the foregoing lectures will be worked by the students, and the results recorded in notebooks which will be periodically examined.

P.8. Laboratory Practice.

Dr. Wynn-Williams, Mrs. Brock and Demonstrators.

The laboratory course is based on the subject matter of the foregoing lectures. The results of experiments and exercises are recorded in note-books which are periodically examined and marked.

FIRST YEAR

P.9. Physics Ancillary to Chemistry.

Dr. Blackman, Mrs. Brock and Mr. Pentz.

A general course of physics of 2 lectures per week throughout the session, and laboratory work for 3 hours per week during the second half-session.

P.10. Physics for Students of Mathematics.

Dr. George and Dr. Allan.

A course of about 50 lectures.

The subject will be treated largely from an experimental point of view, and will include such topics as wave motion, kinetic theory, heat, static and current electricity, conduction of electricity through matter, electronic applications and modern physics.

P.11. Optics and Wave-Motion.

A course of about 44 lectures.

(*a*) Wave Motion—Dr. Stephens.

About 16 lectures.

Syllabus.—The elements of the theory of waves and elementary sound.

(*b*) Wave Theory of Light—Prof. Wright.

About 16 lectures.

Syllabus.—Interference, diffraction and polarization of light.

(*c*) Geometrical Optics—Dr. Hopkins.

About 12 lectures.

Syllabus.—Ray tracing ; the general first-order theory of optical systems ; spherical and chromatic aberrations ; theory of various optical instruments.

P.12. Principles of Electromagnetism.

Prof. S. Devons.

A course of about 30 lectures.

Syllabus :—Concept of field and its sources, potential ; fields produced by charges and currents ; relation between charges and currents ; units.

Measurements of charge, current, and field strength ; simple networks, bridges and instruments ; electromagnetic induction ; A.C. circuits.

Chemical, thermal effects ; macroscopic treatment of susceptibilities ; thermionic emission.

P.13. General Physics.

(*a*) Properties of liquids and solids—Dr. Michiels.

A course of about 20 lectures.

Syllabus :—Surface tension, detergency ; viscosity, plasticity ; cohesion, strength of material, friction ; elasticity ; gravitation.

(*b*) Elementary Thermodynamics—Dr. Klemperer.

A course of about 12 lectures.

Syllabus :—First and second law of thermodynamics ; specific heat ; change of state ; vapour pressure, osmosis ; galvanic cell ; radiation.

P.14. Electrical and magnetic measurements, etc.

Mr. Pentz.

A course of about 9 lectures.

Syllabus :—Production and measurement of electric and magnetic fields ; molecular interpretation and measurement of electric and magnetic susceptibilities ; Langevin theory of paramagnetism and parelectricity ; ferromagnetism ; properties of dielectric materials.

P.15. Laboratory Practice.

and Demonstrators.

Eight hours per week in the first half-session and about twelve hours per week in the second half-session.

The following list is typical of the experiments to be undertaken by the students : viscosity of liquids and gases ; surface tension ; electrolysis ; galvanometry ; thermal conductivity of solids, liquids and gases ; experiments in alternating currents ; magnetic properties of solids and liquids ; depression of freezing point ; measurement of temperature by platinum resistance thermometer and thermocouple ; vacuum practice ; vapour pressure and latent heat determination ; Kater's pendulum ; measurement of the strength of magnetic fields ; measurement of resistance ; determination of the ohm ; simple experiments on interference and diffraction of light ; quantitative measurements on diffusion,

plasticity and osmosis ; electrometers and applications to piezo-electricity and pyro-electricity ; valve characteristics and applications ; elastic hysteresis ; effect of temperature on elastic properties ; emissive powers ; focometry of thick lenses ; focal lines ; spherical aberration.

Second Year

P.16. Sound.

Dr. Aharoni.

A course of 12 lectures.

Syllabus :—Free and forced oscillations of a particle, analogy to electrical oscillations ; vibrating systems of finite size, normal modes ; plane and spherical waves in gases and liquids ; transmission of sound through various media ; sound transmitters and receivers ; physiological acoustics ; acoustic measurements ; technical and musical applications.

P.17. Kinetic Theory.

Dr. Wynn-Williams.

A course of about 20 lectures.

Syllabus :—Maxwell's distribution law of velocities ; application to diffusion, viscosity, and thermal conduction ; Brownian movements in liquids and gases ; emulsions ; theory of slip and temperature drop ; molecular beam technique ; diffraction of molecular beams ; gases and metals ; properties of rarified gases and vacuum practice.

P.18. Spectroscopy.

Dr. Pearse.

A course of about 12 lectures.

Syllabus :—General principles ; determination of wave-lengths ; infra-red and ultra-violet spectra ; methods of producing emission and absorption spectra ; analysis of minerals and alloys ; variations of spectra with experimental conditions ; the various causes of displacement of spectrum lines ; the Zeeman effect ; the analysis of spectra ; series- and term-relationships ; the Bohr theory and its developments : ionisation and resonance potentials ; band spectra ; the Raman effect ; spectra and the periodic table ; astro-physical applications of spectrum theory.

P.19. Wave Mechanics and Relativity.

Mr. Barford and Dr. Aharoni.

A course of about 15 lectures.

Syllabus :—Wave particle aspects of radiation and matter. De Brogli waves. The uncertainty principle. Schrödinger's equation and the interpretation of the wave function. Reflection and transmission of potential barriers. Applications of the theory of *a*-decay, stability of the hydrogen ion, and the emission of electrons from metals. Correlation of dynamical variables and linear operators. The linear harmonic oscillator,

The invariance of physical laws under transformation of frames of reference. The propagation of light. The Lorentz transformation. The applications to kinematics, the conservation of energy and momentum, and electrodynamics.

P.20. Atomic Physics.

Prof. S. Devons, Dr. Klemperer and Mr. Garton.

A course of about 50 lectures dealing with the elements of atomic and nuclear physics.

Syllabus :—Conduction of electricity through gases ; thermionics, photo-electricity ; X-rays ; radioactivity ; atomic structure including isotopes ; nuclear disintegration ; cosmic rays.

P.21. Electromagnetic Theory and Radio-Physics.

Dr. Kellner.

A course of about 25 lectures.

Syllabus :—Transmission line problems ; electromagnetic theory ; refraction and reflexion in insulators and metals ; propagation of electro-magnetic waves in wave-guides ; dispersion in isotropic insulators ; radiation and scattering from dipoles ; application to linear aerials ; production and propagation of ultra-short waves.

P.22. Thermodynamics and Quantum Theory.

Dr. Cochrane and Mr. Barford.

A course of about 30 lectures.

Syllabus :—First law of thermodynamics ; second law of thermodynamics ; thermodynamic functions and relations ; thermodynamic equilibrium ; Nernst heat theorem ; entropy and probability ; Boltzmann statistics ; partition functions ; specific heats of gases and solids ; thermal radiation.

P.23. Laboratory Practice.

Dr. Stephens and Demonstrators.

About 10 hours per week throughout the session.

The experiments fall roughly into two groups, each student performing a representative selection from both. In Group A the experiments are designed essentially to give a practical acquaintance with a wide range of physical phenomena and pnysical instruments, and they normally occupy a shorter time than those in Group B. In this latter group the experiments are of an extended character and often involve measurements to a high order of accuracy. Typical experiments in each group are as follows :—

Group A.—Use of Jamin and Michelson interferometers ; study of defects of a camera lens ; use of miscroscope ; experiments on visual acuity ; optical polarisation phenomena ; characteristics of photo-cells ; platinum resistance,

thermo-couple and radiation pyrometry at high temperatures ; setting up and use of relaxation, A.F. and R.F. oscillating circuits ; properties and applications of rectifiers ; A.C. potentiometer and bridge networks ; properties of electric arc ; properties of gas-filled triodes ; physical properties of plastics ; verification of Paschen's law ; measurement of velocity of sound in gases and solids ; applications of cathode-ray oscillograph to various physical problems ; use of camera in physical measurements ; use of magnetostrictive oscillator for sound velocity determinations ; secondary emission and use of electron multiplier ; sputtering and evaporation technique.

Group B.—Refractive indices of solids, liquids and gases ; specific heats of solids at ordinary and at low temperatures ; calibration of photographic plate ; measurements with Fabry and Perot interferometer ; flicker and photo-electric photometry ; quartz oscillator ; X-ray absorption and ionisation measurements ; use of Geiger counter ; determination of capacity and resistance in absolute units ; infra-red spectrometry ; high-frequency measurements of inductance, etc. ; dielectric constant and power factor at radio frequencies ; discharge-tube measurements.

P.24. Workshop Practice and Glass-Blowing.

Each student during his first and second years undergoes training in soldering, brazing, the use of lathes, etc., in the students' workshop under the direction of Mr. Martin. The facilities of this workshop are also available for the use of postgraduate students. A course of three lectures, with demonstrations, on the technique of glass-blowing will be given by Mr. Weedon at the commencement of the second year course.

P.25. Spectroscopic Laboratory Work.

Dr. Pearse and Demonstrator.

One afternoon per week throughout Course P.18. The work is designed to illustrate the subjects of the lectures and to familiarize students with the practical operations of spectroscopy.

Third Year

In the final year required for the completion of the degree course the student may take, at the discretion of the Professor, an advanced course of study in one of the following departments as approved by the London University Board of Studies : Technical optics, geophysics, meteorology, electrical engineering or aeronautics. A few selected students spend part of their time on research work ; every student taking the advanced course in the physics department is required to attend a course of lectures on a non-scientific subject.

P.26. German.

One hour per week throughout the session. First, Second or Third year students may attend.

P.27. Student Lectures.

Two hours per week devoted to lectures by students on chosen subjects, followed by discussion.

P.28. Advanced Physics.

This course comprises special lecture courses in the Physics Department and during session 1951-52 included lectures on the following topics : Generalised mechanics, statistical mechanics, quantum theory, electro-magnetic theory, diffusion, electron diffraction, fluid motion, solid state, electron optics, switching techniques, applied acoustics and electronics. Lectures and instruction in machine drawing were also given in the Mechanical Engineering Department and certain courses of mathematics were also arranged for the physics students.

In the laboratory the experiments are designed to provide the student with a fuller experience in a limited number of physical fields, than is possible during the previous years of the undergraduate course. Typical experiments are electron diffraction, X-ray crystallography, ultra-high frequency measurements, fluorescence measurements, di-pole determinations, reverberation time measurement, etc. ; in many cases the apparatus will be utilised by the student for the investigation of physical problems suggested by the Professor.

Special Courses for Geology Students.

P.29. Geophysical Prospecting for Oil Students.

Dr. Bruckshaw.

A course of about 25 lectures on the principles of seismic, gravitational and magnetic methods of prospecting, their applications and limitations ; interpretation of results ; electrical and radioactive well logging.

P.30. Principles of Geophysical Prospecting for Oil Students. Practical.

Dr. Bruckshaw and Demonstrator.

Suitable class work and laboratory work to illustrate P.29.

P.31. Geophysical Prospecting for Mining Geology Students.

Dr. Bruckshaw.

A course similar to P.29 specially adapted to the needs of Mining Geology students.

P.32. Geophysical Prospecting for Mining Geology Students. Practical.

Suitable class work and laboratory work, involving the use of simple field instruments, to illustrate P.31.

(The above courses are shown as G.36-37A, pp. 176, 177.)

Advanced Courses.

Special courses of advanced study and/or research are from time to time arranged in all parts of the Physics Department, including spectroscopy. The course may involve research or both research

and advanced study as determined by the Professor. Postgraduate students or external students with suitable qualifications may be admitted to these courses. The general conditions governing research work are given below.

Applications for places in postgraduate work and advanced study are normally considered in the first week in May ; candidates are therefore advised to apply before 1st May.

Technical Optics Section

The Technical Optics Section is a post-graduate Section of the Physics Department and offers systematic courses of training in Technical Optics for students who have either taken a degree course in Physics or Mathematics, or who can show other evidence of suitable preliminary qualifications. A one-year course may also be taken by B.Sc. Honours undergraduates as the final year in their three-year Physics course.

Students who take the course will normally be required to attend lectures on Applied Optics (P.33) and Optical Design (P.34), and will also attend in the optical laboratory for a course of practical instruction (P.36). Students who do not intend to take up work in which a knowledge of optical design is required may, however, take mixed courses combining formal instruction in optics with advanced study or research in such subjects as colorimetry or microscopy.

Examinations may be taken at the end of one or two years leading to the M.Sc. degree or to the Diploma of the Imperial College, or these qualifications may be obtained by research and a thesis on some branch of optics.

Advanced courses in optical design will be arranged, if required, for students who have completed the one-year course, or for other persons with a knowledge of the subject who require advanced instruction. The details of such a course will be adjusted to suit individual requirements, but its general nature will be as follows :—

(*a*) Lectures on the further development of trigonometrical and analytical methods of optical designing, and their application to complex systems, including microscopes and photographic lenses.

(*b*) Class Work in computing.

(*c*) Optical Laboratory Work, which will include the more refined methods of optical measurement and testing, including the measurement of aberrations by the interferometer. Alternatively, arrangements may be made for suitable students to carry out special experimental work designed to give a training in methods of research.

P.33. Applied Optics.

Professor Wright, Mr. B. K. Johnson and Dr. Weinstein.

Syllabus :—The optical system of the eye ; the visual processes ; visual acuity, light sensitivity, discrimination, stereoscopic acuity.

Principles of photometry ; photometric apparatus ; the photometry of optical systems ; the investigation of stray light in optical instruments ; veiling glare.

Optical glass ; its manufacture, working and testing.

Projections systems ; diascopic and episcopic forms ; application to engineering problems ; signalling lamps ; lighthouse projectors.

Telescope systems, erecting devices, resolving power, aberration tests.

Photographic lenses ; general principles relating to the design of the most usual types ; aberrations, sagittal and tangential fields ; methods of testing ; tolerances in the photographic image ; optical performance of modern systems.

Theory and design of optical measuring instruments, including the measuring microscope, theodolite, spectrometer, sextant, refractometer, polarimeter, etc.

Fundamental optical measurements, including focal length determinations, aberration measurements, etc. ; the application of the prism and lens testing interferometer.

Interference Optics, including thin film interference.

P.34. Optical Design.

Dr. Hopkins and Dr. Weinstein.

Ray tracing by calculating machines ; the Gaussian theory of lens systems ; general theory of the Seidel aberrations ; physical measures of aberrations ; diffraction theory of tolerances ; achromatism ; the choice of optical glasses ; analytical methods for systems of thin lenses ; the lay-out of optical systems ; telescope objectives and eyepieces ; lens-mirror systems ; introduction to aberrations of aspheric surfaces ; photographic lenses of simple types.

Class work conducted by Dr. Hopkins and Dr. Weinstein will occupy six hours weekly throughout the session, and will include the practical computing and design of the above optical systems.

P.35. Microscopy.

Mr. B. K. Johnson.

A course of about 6 lectures with laboratory work during the second term.

Syllabus :—Simple and compound microscope ; numerical aperture ; resolving power ; depth of focus ; illumination of the object, transparent and opaque ; dark-ground illumination ; the ultra-microscope ; phase-contrast illuminator ; interference method for measurement of ultra-microscopic particles ; photomicrography ; resolving power of plate ; metallurgical microscopes ; binocular instruments ; application of polarized light to the microscope ; the ultra-violet microscope ; the problem of using shorter and shorter wavelengths ; U.V. reflection microscopes ; electron microscope.

P.36. Optical Laboratory.

The use and testing of telescopes, microscopes, photographic lenses, etc. ; refractometry ; experiments on diffraction and phase contrast ; interferometry, including thin film interference ; polarisation experiments ; visual and photo-electric spectro-photometry ; experiments on stereoscopic vision and stereoscopic photography, etc. Workshop practice in lens grinding and polishing.

P.37. Special Short Courses in Technical Optics.

From time to time, courses of lectures and practical work are arranged in special subjects, amongst which are :—

Diffraction of aberrations.
Photometry of Optical Instruments.
Spectro-photometry.
The measurement of colour.

Particulars of all the above courses will be announced as occasion arises.

Course on Geophysical Prospecting

This Course deals with the application of Physics to the elucidation of underground geological structures in relation to the location of economic minerals. It consists of the following parts :—

P.38. Gravitational Prospecting.

About 45 lectures.

General description of the earth's gravitational field. Isostasy. Tide raising forces. Measurement of gravity by pendulums and gravity meters. The reduction of gravity observations. The Eotvos torsion balance and the corrections to the measurements. The calculation of gravity effects and the interpretation of gravity surveys.

P.39. Magnetic Prospecting.

About 24 lectures.

The earth's magnetic field and its measurement. Field variometers. Magnetic properties of minerals and rocks. The magnetic anomaly due to susceptibility contrasts. The relation between magnetic and gravity anomalies. The application to field problems.

P.40. Seismic Prospecting.

About 35 lectures.

The theory of elasticity and the propagation of mechanical disturbances through continuous bodies. The influence of rock boundaries on their transmission. Seismographs. Refraction prospecting including profile, correlation refraction, arc and fan shooting. Reflection prospecting including correlation and dip shooting and continuous profiling.

P.41. Electrical and Miscellaneous Prospecting Methods.

About 30 lectures.

The distribution of direct and alternating currents in continuous media. The electrical properties of rocks. Spontaneous polarization. Surface potential methods including resistivity measurements, ratiometer measurements and equipotential investigations. Resistivity measurements and natural potentials in boreholes. Inductive measurements.

Radioactive properties of rocks and their use in surface prospecting and well-logging.

Geothermal measurements.

P.42. Practical Work in the Laboratory.

This includes the use of field instruments, and class work in computing results and the interpretation of field surveys. When possible short field excursions are arranged.

A course of lectures and practical work in geology, specially adapted to meet the needs of geophysics students, including physical geology, mineralogy of common rock forming minerals, petrology of the main types of igneous, sedimentary and metamorphic rocks, structural geology, stratigraphy, geological survey methods, the nature and origin of economic mineral deposits, water supply, etc.

A course in Elementary Surveying for Geophysics students (Min. 15), including two weeks' field work at Tywarnhale Mine, Cornwall, is provided in the Mining Department.

The Diploma of the Imperial College (D.I.C.) may be awarded to qualified students taking the full course in Geophysics. The Degree of M.Sc. by examination may also be taken by suitably qualified students.

Research.

Postgraduate work in Physics is organised to provide for disinterested research in all branches of the subject, as well as courses in preparation for higher degrees and diplomas. At the present time the subjects of research being pursued within the Department include the following : nuclear physics (including cosmic rays and allied subjects), electron diffraction, spectroscopy, technical optics, geophysics, acoustics (including ultrasonics), and electron optics.

Students are admitted on the recommendation of the Professor, which will be given only to those who have obtained the A.R.C.S. diploma or B.Sc. Degree in Physics or can produce evidence of equivalent qualifications.

Research students are required to make good all injury, other than legitimate wear and tear, which may be done by them to apparatus belonging to the College.

Students who have passed their examinations for the Bachelor's Degree may apply to be registered for the D.I.C. or the M.Sc., Ph.D., or D.Sc. Degree in Physics. The courses of study or research will be determined by the Professor to suit individual cases.

PHYSICS

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Pure Mathematics M.6.	Physics Laboratory	Theoretical Mechanics M.9.	Pure Mathematics M.6.	Theoretical Mechanics M.9.
11–12.					
12–1.	Physics Lecture	Physics Lecture	Mathematics M.12.	Physics Lecture	Physics Lecture
2–3.	Mathematics M.12.	Physics Classwork	Reading	Pure Mathematics M.6.	Physics Lecture
3–4.	Physics Laboratory	Physics Laboratory		Statistics M.11.	Physics Laboratory
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Physics Lecture	Mathematical Physics M.8.	Mathematical Physics M.8.	Physics Laboratory	Pure Mathematics M.6.
11–12.	Physics Laboratory				
12–1.		Physics Lecture	Physics Lecture	Physics Lecture	Physics Lecture
2–3.	Physics Laboratory	Physics Lecture or Reading	Reading	Physics Laboratory	Physics Lecture or Reading
3–4.		Mathematics M.6.			Physics Classwork
4–5.					

SECOND YEAR—Whole Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Physics Lecture	Physics Lecture	Physics Lecture	Physics Lecture	Physics Lecture
11–12.	Theoretical Dynamics M.24.	Physics Laboratory	Reading	Physics Laboratory	Reading
12–1.			Physics Lecture		
2–3.	Physics Lecture	Physics Laboratory	Reading	Physics Laboratory	Reading
3–4.	Reading				
4–5.					

DEPARTMENT OF ZOOLOGY AND APPLIED ENTOMOLOGY

The Department of Zoology and Applied Entomology is housed in Prince Consort Road. The elementary laboratory contains 25 places for students taking First Year courses. Two advanced laboratories contain places for 25 students in all and research laboratories afford accommodation for 15 workers. In addition to the above there are : lecture theatre ; library containing 6,000 volumes and 2,500 pamphlets ; a collection of museum specimens for teaching and research purposes ; constant temperature rooms ; photographic and dark rooms ; tank room. The department also contains Professor T. H. Huxley's library, museum of specimens and personalia.

Undergraduate Courses.

As the courses for Zoology and Botany students are identical until half-way through the first half-session of the First Year, a student may apply for transfer from one course to the other during this period. In the Department of Zoology and Applied Entomology students take a course leading to the Zoology Degree, and the courses of all Zoology students are identical until the end of the Second Year. Their botanical training includes courses on the morphology and anatomy of representatives of the main groups of the vegetable kingdom, on the ecology and taxonomy of flowering plants and on vegetable physiology and pathology. The zoological courses deal with the comparative anatomy, physiology, embryology, and classification of the animal kingdom based on a study of types of the main groups, the theories of heredity and evolution, cytology and genetics, geographical distribution, ecology.

Special attention is given to entomology for which the Department is especially well equipped, both for teaching and for research.

Students entering the First Year are expected to possess a knowledge of the elements of Organic Chemistry and a standard in Mathematics (Pure and Applied) at least equivalent to Ordinary level at the General Certificate of Education.

Field work in the long vacations following the First and Second Years and a Marine Course in the Easter Vacation of the Second Year are essential parts of the curriculum.

Associateship and Degree Course in Zoology.

Intermediate Year

First Half-Session :—

Physics, P.1, P.2, P.13, P.4, P.5, P.6, P.7, P.8.
Pure Mathematics—M.1.

Second Half-Session :—

Chemistry—C.021, C.041, C.042, C.047.
Applied Mathematics—M.2.

First Year

No exemption is given from the work of the Second Half-Session of the First Year to candidates for the Associateship.

First Half-Session :—

Zoology—Z.1, Z.2.
Botany—B.22, B.22a.

Second Half-Session :—

Zoology—Z.3.
Geology—G.1, G.2, G.3 or Chemistry C.115, C.123.

Second Year

No exemption is given from the work of the second and third years to candidates for the Associateship.

First Term :—

Zoology—Z.4, Z.5.
Botany—B.23.

Second Term :—

Zoology—Z.4.
Botany—B.23, B.24.

Third Term :—

Zoology—Z.6.
Botany—B.25.

Third Year

The formal work of the Third Year is undertaken in the First and Second Terms and varies according to the individual requirements of the student. Details should be settled after consultation with the Professor. The Third Team is occupied in field work and/or original research.

Final Examinations.

Final Examinations are taken in two parts ; the first part, in June of the Second Year, is based on the zoological and botanical courses of the Second Half-Session of the First Year and of the whole Second Year ; the second part, in March of the Third Year, is based on the Third Year courses. The award of the Associateship and Degree is recommended in June or July of the Third Year after consideration of the field work and/or research.

Syllabuses.

Z.1. General and Elementary Zoology.

Mr. Hewer.

Syllabus :—An introduction to the comparative anatomy of animals, with special reference to those types which are examined in the laboratory (*see* Z.2) ; the elements of animal physiology and reproduction ; the basic principles of embryology as exemplified by the development of amphioxus and frog ; types of animal tissues ; the principles of classification.

Z.2. Elementary Laboratory Work.

Syllabus :—All or some of the following types will be studied in detail : *Amoeba, Polystomella, Paramecium, Vorticella, Euglena, Trypanosoma, Volvox, Monocystis, Laverania, Hydra, Obelia, Fasciola, Lumbricus, Astacus, Periplaneta, Anodonta, Helix, Branchiostoma, Scylliorhynus, Rana, Oryctolagus.* Also the development of amphioxus and frog.

Z.3. Advanced Vertebrate Zoology.

Dr. Wagge.

Syllabus :—A course of about 40 lectures with practical work on the comparative anatomy and classification of vertebrate animals, with special reference to the types of the following groups : Hemichorda, Urochorda, Cephalochorda, Cyclostomata, Selachii, Pisces, Amphibia, Reptilia, Aves and Mammalia.

Z.4. Advanced Invertebrate Zoology.

Dr. Gorvett.

Syllabus :—A general course on the morphology and classification of the invertebrate phyla, with special reference to the types in the following groups : Protozoa : *Sarcodina, Mastigophora, Ciliophora, Sporozoa* ; Porifera : Coelenterata : *Hydrozoa, Scyphozoa, Anthozoa, Ctenophora ;* Platyhelminthes : *Turbellaria, Trematoda, Cestoda ;* Annalida : *Polychaeta, Oligochaeta, Hirudinea, Echiuroidea ;* Padaxonia : *Phoronidea, Polyzoa, Brachiopoda ;* Arthropoda : *Onychophora, Crustacea, Arachnida, Myriapoda, Insecta ;* Mollusca : *Gastropoda, Pelecypoda, Cephalopoda ;* Echmodermata : *Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea, Crinoidea.*

Z.5. Vertebrate Embryology.

Mr. Hewer.

Syllabus :—A series of lectures with practical work on the germ-cells, fertilisation, sementation, gastrulation and formation of the germ-layers will be studied comparatively in *Amphioxus, Anura, Urodela, Selachii, Teleosts Gymnophiona, Reptilia* (Gecko), *Aves* (Chick) *Mammalia ;* early development of the organs of the chick (up to the 4th-5th days) ; amniote membranes—the amnion, chorion, allantois and yolk-sac ; the membranes in the mammalia —the amnion, allantois and placenta.

Z.6. Biochemistry and Physiology.

Dr. Murray.

A course of about 20 lectures with practical work.

Z.11. Evolution.

Mr. Hewer and Dr. Richards.

A series of 24 lectures in the Second Term. The subjects dealt with will include : Geographical distribution, theories of evolution.

Z.21. Principles of Applied Entomology.

Prof. Munro.

A course of 10 lectures.

Z.22. Systematic Entomology.

Dr. Richards, Mr. Davies, and Dr. Boratynski.

An advanced course of 25 lectures during the First Term on external morphology, with special reference to structures used in classification, e.g., wing venation, genitalia ; modification of body structure ; conspectus of orders and families, principles of taxonomy ; classification. Practical work follows the lectures.

Z.23. Physiology of Insects.

Dr. Murray and Dr. Waloff.

An advanced course of about 20 lectures and practicals at times to be arranged.

Z.24. Internal Anatomy of Insects.

Mr. R. G. Davies.

A course of 4 lectures and practicals.

B.11. Cytology and Genetics.

Mr. Howarth.

Zoologists attend part of this course.

Z.25. Ecology of Insects.

Dr. Richards and Dr. Waloff.

A course of 10 lectures with practical work in the Third Term.

Z.26. General Entomology.

Prof. Munro and Dr. Boratynski.

A special course of 10 lectures in the Second Term, arranged for Botany Students in the Botany Department : General morphology, internal anatomy, development and metamorphosis of insects with special reference to their relationship to plants.

Z.27. Applied Entomology in the Tropics.

Dr. Jepson.

A course of 5 lectures.

Z.28. Insecticides and their Application.

Dr. Page and Mr. Higgins.

A course of 10 lectures with practical work.

Z.29. Principles of Entomology.

Dr. Jepson.

An introductory course for Public Health Engineers.

Advanced and Postgraduate Work.

Advanced study and research both in pure and applied Zoology are provided for, with special emphasis on field studies in ecology and on animal populations and on applied entomology. To meet the need of Colonial Office students, special courses in stored products entomology are provided, with facilities for research on its various problems.

Most of the advanced study and research is carried out at the College Field Station, Silwood Park, Sunninghill, Berks, and the final term is spent by students at the Field Station.

The Station comprises two former residential buildings on two adjoining estates, Silwood Park and Ashurst Lodge. Silwood Park is in part equipped as laboratories for work in ecology and meteorology, and in part as a hostel for staff and students. Ashurst Lodge is equipped as laboratories for applied entomology including work on chemical and physical methods for the control of insects and other pests.

ZOOLOGY

(*The Intermediate Year Time-Table will be found on p.* 60.)

FIRST YEAR—First Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Zoology Lecture Z.1.	Botany Lecture B.22.	Zoology Lecture Z.1.	Botany Lecture B.22.	Zoology Lecture Z.1.
11–12.	Zoology Laboratory Z.2.	Botany Laboratory B.22a.	Zoology Laboratory Z.2.	Botany Laboratory B.22a.	Zoology Laboratory Z.2.
12–1.					
2–3.	Zoology Laboratory Z.2.	Botany Laboratory B.22a.	Zoology Laboratory Z.2.	Botany Laboratory B.22a.	Botany Lecture B.22.
3–4.					Botany Laboratory B.22a.
4–5.					

FIRST YEAR—Second Half-Session

Hours.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
10–11.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.	Geology Lecture G.1.
11–12.	Geology Laboratory G.2.	Zoology	Geology Laboratory G.2.	Geology Laboratory G.2.	Geology Laboratory G.2.
12–1.				Palæontology Lecture G.1.	
2–3.	Zoology Lecture Z.3.	Zoology Laboratory Z.3.	Zoology Lecture Z.3.	Palæontology Laboratory G.2.	Zoology Lecture Z.3.
3–4.	Zoology Laboratory Z.3.		Zoology Laboratory Z.3.		Zoology Laboratory Z.3.
4–5.					

Students taking Chemistry follow courses C.115, C.123 in place of Geology above.

The time-tables for the Second and Third Years are arranged in the Department.

AWARDS TO STUDENTS DURING SESSION 1951-52

DIPLOMA OF MEMBERSHIP OF THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (D.I.C.)

(From May, 1952, no distinction is made between Advanced Study and Research in D.I.C. awards.)

Year awarded Diploma.	Name.	Subject.
1952	Abdalla, Zaher Baher	Civil Engineering—Public Health Engineering.
1951	Advani, Chandru Tillumal ...	Civil Engineering—Hydro-Power Engineering (*b*).
1952	Allan, Robert Malcolm ...	Aeronautics.
1952	Anderson, James Treat ...	Mechanical Engineering.
1952	Armstrong, Margaret Taggart (née Stewart)	Entomology.
1951	Arya, Om Prakash	Organic Chemistry (*a*).
1952	Ausburn, Kenneth John ...	Electrical Engineering (*a*).
1952	Baker, Edward Herbert ...	Physical Chemistry.
1952	Ballantyne, Ernest Harold ...	Electrical Engineering.
1951	Balsara, Jamshed Sorabji ...	Chemistry of Food and Drugs (*c*).
1952	Banks, Robert Blackburn ...	Civil Engineering—Fluid Mechanics.
1952	Barnes, William Neil	Biochemistry (*b*).
1951	Bazett, Donald John	Civil Engineering—Soil Mechanics (*b*).
1951	Berger, Jan	Civil Engineering—Theory of Structures (*b*).
1952	Bharucha, Kekmusroo Rustomji	Organic Chemistry.
1951	Bishop, Geoffrey Stanley ...	Mathematics (*b*).
1951	Black, Robert Alexander Ross	Aeronautics (*b*).
1952	Blaschke, Walter Siegfried Siegismund	Technical Optics (*b*).
1951	Blight, Philip Arthur	Statistics (*b*).
1951	Blood, Cyril Thomas	Organic Chemistry (*a*).
1951	Bluhm, Max Michael	Applied Physical Chemistry (*a*).
1952	Bolton, Richard Sharpe ...	Civil Engineering—Hydro-Power Engineering (*b*).
1951	Boratynski, Kajetan Ludwik ...	Entomology (*a*).
1951	Bristow, Howard Arthur Stanley	Chemical Engineering (*b*).
1952	Brown, William Christopher ...	Civil Engineering—Structural Engineering (*a*).
1952	Campbell-Little, Donald John	Civil Engineering—Public Health Engineering.

(*a*) Research ; (*b*) Research and Advanced Study ; (*c*) Advanced Study.

Year awarded Diploma.	Name.	Subject.
1952	Capellaro, David Francesco ...	Technical Optics.
1952	Cassell, Alfred Carlo	Civil Engineering—Structures
1952	Catterall, John Ashley ...	Metallurgy.
1952	Chandrangsu, Sirilakn ...	Civil Engineering—Structures.
1951	Chaudhary, Muhammad Tufail	Physical Chemistry (*b*).
1952	Chetty, Salom Thirumalaiswami-chetty Krishnaswamy	Technical Optics.
1952	Chivers, John	Chemical Engineering.
1951	Cohen, Moise Jacob	Aeronautics (*b*).
1952	Coleman, Max	Chemical Engineering (*a*).
1951	Cooper, Graham Baptie ...	Inorganic Chemistry (*a*).
1952	Cuming, Henry George ...	Aeronautics (*a*).
1951	David, Ieuan	Inorganic Chemistry (*b*).
1952	Davies, Austen Emlyn ...	Physical Chemistry (*b*).
1951	Devanathan, Michael Angelo Vincent	Physical Chemistry (*b*).
1951	Devereux, Walter Frank ...	Civil Engineering—Public Health Engineering (*b*).
1952	Dhar, Manmohan	Civil Engineering—Structures.
1952	Dombrowski, Norman ...	Chemical Engineering.
1951	Doyle, William Patrick ...	Physical Chemistry (*b*).
1951	Dubhashi, Jaywant Dipa ...	Civil Engineering—Fluid Mechanics and Hydraulic Engineering (*a*).
1951	Dunton, David Anthony ...	Civil Engineering—Concrete Technology (*b*).
1952	Dutt, Amitava	Geology.
1951	Eid, Yehya Mohamed	Civil Engineering—Public Health Engineering (*b*).
1952	El Nahal, Abd El Kader Mostafa	Entomology.
1951	El-Salman, Jamal Abdul Wahab	Civil Engineering—Concrete Technology (*b*).
1952	Evans, Geoffrey Luther ...	Metallurgy.
1951	Evans, John Walter	Physical Chemistry (*b*).
1952	Everard, Kenneth Arthur ...	Civil Engineering—Concrete Technology.
1951	Faure, Anthony Gerhard ...	Inorganic Chemistry (*a*).
1952	Flinn, Derek	Geology.
1952	Folkierski, Andrzej	Physics.
1951	Ford, John Hugo	Statistics (*b*).
1952	Foster, Bryan Kershaw ...	Civil Engineering—Structures.
1951	Fox, Manfred	Physical Chemistry (*a*).
1951	Franklin, John Edward ...	Civil Engineering—Concrete Technology (*b*).

(*a*) Research ; (*b*) Research and Advanced Study ; (*c*) Advanced Study.

Year awarded Diploma.	Name.	Subject.
1951	Gadd, George Edward... ...	Aeronautics (*a*).
1951	Gibbs, James Edmund ...	Technical Optics (*a*).
1952	Gibson, Robert Edward ...	Civil Engineering—Soil Mechanics (*a*).
1951	Goodall, William Alexander ...	Aeronautics (*b*).
1951	Graff, Samuel	Civil Engineering—Concrete Technology (*b*).
1951	Greenway, Michael William	Electrical Engineering (*a*).
1951	Grieve, Ian Alastair	Mechanical Engineering (*b*).
1951	Grimaldi B., Luis Jaginto ...	Civil Engineering—Public Health Engineering (*b*).
1951	Groves, Frank Alec	Chemical Engineering (*a*).
1951	Haas, Harold Williams ...	Chemical Engineering (*a*).
1951	Hart, Raymond Kenneth ...	Applied Physical Chemistry (*a*).
1952	Hassid, Samy	Civil Engineering—Structures.
1951	Hobbs, Noel Bambury ...	Civil Engineering—Soil Mechanics (*b*).
1951	Hobden, Stephen Lee	Civil Engineering—Soil Mechanics (*b*).
1952	Holland, Frederick Anthony ...	Chemical Engineering
1952	Holness, Norris John	Physical Chemistry (*b*).
1951	Holroyd, Frank Gordon ...	Civil Engineering—Concrete Technology (*b*).
1952	Hope, Lancelot John	Aeronautics.
1952	Hsiung, Chao-Yu	Civil Engineering—Structural Engineering (*b*).
1951	Hsu, Tze-Wen	Electrical Engineering (*b*).
1952	Hughes, James Ernest ...	Metallurgy.
1951	Jackson, James Keith	Civil Engineering—Concrete Technology (*b*).
1951	Jacobs, Patrick William McCarthy	Physical Chemistry (*b*).
1952	Jaworski, Zbigniew Ernest ...	Electrical Engineering.
1951	Jefford, Godfrey	Analytical Chemistry (*c*).
1951	Johnsen, Kjell	Electrical Engineering (*a*).
1951	Jones, Neal Kenneth	Electrical Engineering (*a*).
1951	Joshi, Janardin Diwaker ...	Chemical Engineering (*a*).
1951	Kakish, Fouad Id	Civil Engineering—Public Health Engineering (*b*).
1951	Kale, Mahadev Ramchandra ...	Civil Engineering—Hydro-Power Engineering (*b*).
1951	Kaminsky, Simon	Physical Chemistry (*b*).
1952	Kapany, Narinder Singh ...	Technical Optics.
1951	Kestek, Zuhtu	Mechanical Engineering (*b*).
1952	Kirec, Yavuz	Civil Engineering—Soil Mechanics.

(*a*) Research ; (*b*) Research and Advanced Study ; (*c*) Advanced Study.

Year awarded Diploma.	Name.	Subject.
1952	Küçükkoca, Necdet	Entomology.
1951	Kvia, Tönnes	Chemistry of Food and Drugs (*c*).
1951	Landauer, Phyllis Downton (Mrs.)	Organic Chemistry (*a*).
1951	Landauer, Stephen Klaus Robert.	Organic Chemistry (*a*).
1951	Langdon, John	Civil Engineering—Concrete Technology (*b*).
1951	Law, John Trevor	Physical Chemistry (*b*).
1951	Leese, Cecil Leslie	Organic Chemistry (*a*).
1951	Leibowitz, Bernard	Civil Engineering—Concrete Technology (*b*).
1952	Leng, Geoffrey	Electrical Engineering.
1951	Leu, Kurt Werner	Applied Physical Chemistry (*a*).
1951	Levy, Geoffrey Howden ...	Civil Engineering—Concrete Technology (*b*).
1952	Love, David Christopher ...	Chemical Engineering.
1951	Lucas, Lloyd Newton Douglas	Physics (*a*).
1952	Ludbrook, Nelly Hooper (Mrs.)	Geology.
1951	McCallum, Neil	Chemical Technology—Refractories (*a*).
1951	MacDonald, Roderick Duncan	Electrical Engineering (*b*).
1952	Mackworth, Richard Charles Audley	Mechanical Engineering (*a*).
1952	Madon, Homi Nusserwanji ...	Chemical Technology.
1952	Martin, Alfred John	Metallurgy.
1951	Martin, Peter Francis	Civil Engineering—Public Health Engineering (*b*).
1952	Micklem, John Dennis ...	Aeronautics.
1952	Monteith, John Lennox ...	Meteorology.
1952	Moore, Peter Thomas	Metallurgy.
1951	Morgan, Colin Edgar	Agricultural Chemistry (*b*).
1951	Munasinha, Munasinha Aratchi Lekamalage Earle Indraratna	Civil Engineering—Hydro-Power Engineering (*b*).
1952	Narain, Chandra	Chemical Engineering (*a*).
1952	Nasser, Mohamed Ibrahim ...	Technical Optics.
1951	Nath, Rajendralal	Organic Chemistry (*a*).
1951	Nawy, Edward George ...	Civil Engineering—Concrete Technology (*b*).
1952	Neale, Robert Francis	Chemical Technology.
1951	Newman, Dennis Daniel Ernest	Organic Chemistry (*a*).
1952	Oehler, Le Roy Theodore ...	Civil Engineering—Concrete Technology.
1952	Oldfield, Lucy Florence ...	Physical Chemistry (*b*).
1951	Phillips, Edmor	Metallurgy (*c*).

(*a*) Research ; (*b*) Research and Advanced Study ; (*c*) Advanced Study.

Year awarded Diploma.	Name.	Subject.
1951	Pinney, Colin Michael	Mathematics (*b*).
1951	Plowman, John Marks ...	Civil Engineering—Concrete Technology (*a*).
1952	Powlesland, Mary Ruth ...	Plant Pathology.
1952	Pun, Yin Keung	Civil Engineering—Concrete Technology.
1952	Rahimtoola, Mohamed Hoosen Ali	Civil Engineering—Public Health Engineering.
1952	Rahman, Latifar	Civil Engineering—Public Health Engineering.
1951	Randall, David George ...	Mathematics (*b*).
1951	Ray, Debesh Chandra	Technical Optics (*c*).
1952	Rayner, Charles Beresford ...	Mathematics (*b*).
1952	Révész, István	Civil Engineering—Concrete Technology.
1952	Roberts, Donald Van Norman	Civil Engineering—Soil Mechanics.
1951	Rosenfelder, Walter Jacob ...	Physical Chemistry (*b*).
1951	Russell, John	Plant Physiology (*a*).
1952	Ruyabhorn, Pravit	Civil Engineering—Structures.
1951	Sadek, Ramadan	Civil Engineering—Fluid Mechanics and Hydraulic Engineering (*a*).
1951	Salmond, Kate Fraser	Entomology (*b*).
1951	Sands, William Alexander ...	Entomology (*b*).
1952	Savoie, André Pierre	Civil Engineering—Public Health Engineering.
1952	Schilizzi, John Nicolas ...	Mechanical Engineering.
1952	Sen, Debabrata	Chemical Technology (*a*).
1951	Shelton, Allen	Mechanical Engineering (*b*).
1951	Sims, Peter	Organic Chemistry (*a*).
1951	Sinbel, Mohamed Attafy ...	Civil Engineering—Hydro-Power Engineering (*b*).
1951	Skinner, Stanley John ...	Chemical Engineering (*a*).
1951	Smith, John Frederick ...	Organic Chemistry (*a*).
1951	Sneller, Alec Thomas	Civil Engineering—Public Health Engineering (*b*).
1952	Soontarotok, Prasert	Meteorology.
1951	Spanner, Douglas Clement ...	Plant Physiology (*a*).
1951	Spratt, Donald Alexander ...	Physical Chemistry (*b*).
1951	Spurr, Robert Thomas ...	Applied Physical Chemistry (*a*).
1952	Stephenson, Donald George ...	Mechanical Engineering.
1952	Sullivan, Timothy Stephen ...	Civil Engineering—Public Health Engineering.
1952	Summers, Peter William ...	Meteorology.

(*a*) Research ; (*b*) Research and Advanced Study ; (*c*) Advanced Study.

Year awarded Diploma.	Name.	Subject.
1951	Sykes, Donald	Electrical Engineering (*b*).
1952	Tatchell, John Sutton	Aeronautics.
1951	Thomas, David Henry William	Civil Engineering—Public Health Engineering (*b*).
1951	Thomas, Gwyn	Geology (*a*).
1952	Tribe, Henry Timothy	Plant Pathology (*a*).
1952	Tucker, Gilbert Brian	Meteorology.
1951	Vallet, Louis Adolphe Paul ...	Civil Engineering—Public Health Engineering (*b*).
1951	van Raalte, Thomas Leon ...	Technical Optics (*c*).
1952	Wanford, David Walter Beresford	Mathematics (*b*).
1951	Warren, David Ronald de Mey	Chemical Technology (*a*).
1951	Watson, Reginald Gordon Harry	Physical Chemistry (*b*).
1951	Webb, Donald Percy Dennis ...	Applied Physical Chemistry (*a*).
1951	Wilkins, George Alan	Mathematics (*b*).
1952	Wilson, Theodore George Gilchrist	Physical Chemistry.
1951	Wood, Robert Edward ...	Civil Engineering—Concrete Technology (*b*).
1951	Woods, Robert James	Organic Chemistry (*a*).
1952	Wurtele, Douglas Barnett ...	Aeronautics.
1952	Yang, Wan-Sun...	Technical Optics.
1951	Zaki, Mohib Mohamed ...	Agricultural Chemistry (*b*).
1952	Ziauddin, Varusai Miskin Shamsuddin	Civil Engineering—Concrete Technology.

(*a*) Research ; (*b*) Research and Advanced Study ; (*c*) Advanced Study.

DIPLOMA OF ASSOCIATESHIP OF THE ROYAL COLLEGE OF SCIENCE (A.R.C.S.)

Session.	Name.	Department.
1949–52	Askew, John Russell	Mathematics (1st Class).
1949–52	Atkinson, David John	Geology (1st Class).
1947–50	Aylett, John Goldring	Chemistry (Pass).
1949–52	Bacon, Roy Desmond	Chemistry (2nd Class).
1949–52	Baguley, Maurice Edward	Chemistry (1st Class).
1949–52	Baker, Bryan William	Chemistry (2nd Class).
1949–52	Baker, Leonard Charles	Chemistry (2nd Class).
1949–52	Barnes, Roger Francis	Botany (2nd Class).
1949–52	Bennett, Stuart Norman	Mathematics (Pass).
1949–52	Bowen, Jean Constance	Zoology (Pass)
1948–52	Brown, Keith Francis...	Botany (2nd Class).
1949–52	Buckroyd, Bernard Watson	Mathematics (2nd Class).
1949–52	Carolin, Roger Charles	Botany (2nd Class).
1949–52	Cavanagh, Gerald Gilbert	Zoology (2nd Class).
1949–52	Champney, Maurice Anthony ...	Chemistry (2nd Class).
1945–47 1949–52	Chayen, Ralph	Chemistry (2nd Class).
1949–52	Clayton, William Derek	Botany (1st Class).
1948–52	Coaker, Thomas Henry	Zoology (2nd Class).
1948–52	Cooray, Percival Gerald	Geology (1st Class).
1949–52	Coppelman, Stanley	Mathematics (2nd Class).
1949–52	Dennis, John Alan	Physics (2nd Class).
1949–52	Dixon, Norman Edward	Physics (Pass).
1949–52	Doust, Roy Hamilton	Chemistry (Pass).
1949–52	East, Kenneth John	Mathematics (Pass).
1949–52	Edmonds, Peter Derek	Physics (2nd Class).
1949–52	Elias, Richard Stewart	Botany (2nd Class).
1949–52	Ellison, Eric Lewis	Mathematics (2nd Class).
1949–52	Evans, Eustace Anthony	Chemistry (1st Class).
1949–52	Farlie, Dennis John Gerald	Mathematics (1st Class).
1949–52	Fermer, Michael Thorpe	Mathematics (2nd Class).
1949–52	Flower, Douglas James	Mathematics (2nd Class).
1949–52	Garnish, Edward William	Chemistry (Pass).
1949–52	Golden, John Henry	Chemistry (1st Class).
1949–52	Gooberman, Lancelot George ...	Physics (2nd Class).
1948–51	Goss, Walter Percival...	Physics (Pass).
1949–52	Green, John Stephen	Mathematics (1st Class).
1949–52	Gregory, Norman Lennox	Physics (Pass).
1948–52	Hague, Nigel Graham Mackenzie ...	Zoology (2nd Class).
1949–52	Hancock, Norman Alfred	Zoology (Pass).
1949–52	Harding, Peter David	Mathematics (Pass).
1949–52	Haswell, George Alan	Zoology (2nd Class).
1949–52	Heasell, Edwin Lovell	Physics (2nd Class).

Session.	Name.	Department.
1949–52	Hornsby, John Slindon	Mathematics (1st Class).
1949–52	Hunter, Neville John	Chemistry (2nd Class).
1949–52	Ives, David Arthur John	Chemistry (Pass).
1949–52	Johnson, Martin Keith	Chemistry (2nd Class).
1949–52	Jones, Tecwyn	Zoology (2nd Class).
1949–52	Kaye, Stephen	Physics (Pass).
1949–52	Kehoe, Richard Brian	Physics (1st Class).
1949–52	Laming, Deryck James Colson ...	Geology (1st Class).
1949–52	Levy, Ashley Angel	Chemistry (2nd Class).
1949–52	Levy, Robin Bruce	Chemistry (2nd Class).
1949–52	Manning, Geoffrey	Physics (1st Class).
1949–52	Middleton, Gerard Viner	Geology (1st Class).
1949–52	Mortimer, Thomas Jackson ...	Zoology (2nd Class).
1949–52	Newman, Ronald Charles	Physics (1st Class).
1949–52	O'Brien, John Patrick	Mathematics (2nd Class).
1949–52	Oglesby, Stanley	Mathematics (1st Class).
1949–52	Parks, Michael John	Mathematics (2nd Class).
1949–52	Partridge, Alan Torrington	Physics (2nd Class).
1949–52	Phillips, Robert William	Geology (2nd Class).
1949–52	Price, David Christopher	Chemistry (1st Class).
1949–52	Price, Donald Roy Charles	Physics (2nd Class).
1949–52	Ramsay, John Graham	Geology (1st Class).
1949–52	Rosenbaum, Stanley Daniel	Physics (Pass).
1948–52	Ross, John Victor	Geology (2nd Class).
1948–52	Runeckles, Victor Charles	Botany (1st Class).
1949–52	Sadler, Donald Sidney	Mathematics (1st Class).
1949–52	Schiff, Bernard	Mathematics (1st Class).
1948–52	Sear, Roderick Henry	Physics (2nd Class).
1948–52	Simons, Ronald Harvey	Zoology (2nd Class).
1949–52	Slater, Charles Albert...	Chemistry (1st Class).
1950–52	Smith, Alan Graham (A.R.C.S. Physics)	Mathematics (Pass).
1949–52	Smith, Arnold John	Chemistry (2nd Class).
1949–52	Smith, Michael John	Physics (Pass).
1949–52	Smith, Peter Harold	Mathematics (2nd Class).
1949–52	Southwood, Thomas Richard Edmund	Zoology (1st Class).
1949–52	Steers, Edward Baddeley Mitchell ...	Physics (2nd Class).
1949–52	Stone, Derek John	Mathematics (1st Class).
1947–52	Thomas, Harold Sidney Hampton ...	Geology (Pass).
1949–52	Thresh, John Michael	Botany (2nd Class).
1949–52	Tibbetts, Derek Ross	Physics (Pass).
1949–52	Tidman, Derek Albert	Physics (2nd Class).
1949–52	van den Heuvel, Michael Joseph ...	Zoology (Pass).
1949–52	Wardle, Stanley	Mathematics (1st Class).
1949–52	Williams, Roy Francis	Mathematics (2nd Class).

Session.	Name.	Department.
1949–52	Willrich, Dorothea Britta	Zoology (2nd Class).
1949–52	Wright, Christopher Amyas	Zoology (1st Class).
1949–52	Young, David Anderson	Chemistry (2nd Class).

DIPLOMA OF ASSOCIATESHIP OF THE ROYAL SCHOOL OF MINES (A.R.S.M.)

Session.	Name.	Department.
1949–52	Almond, John Kenneth	Metallurgy (2nd Class).
1949–52	Baird, William Kelvin	Mining (2nd Class).
1948–52	Barleggs, Roy Ernest	Metallurgy (1st Class).
1948–52	Barry, Beresford Thomas Kingcome	Metallurgy (2nd Class).
1949–52	Bell, Edward Arthur	Mining (Pass).
1949–52	Birch, John William	Mining (2nd Class).
1948–52	Bowtell, Donald George	Oil Technology (2nd Class).
1949–52	Brewis, Antony Arthur Carrick ...	Mining (2nd Class).
1949–52	Brown, George Arthur	Mining Geology (2nd Class).
1949–52	Butler, Ronald David	Metallurgy (2nd Class).
1948–52	Catterall, Graham John	Metallurgy (2nd Class).
1949–52	Clow, Colin George	Metallurgy (2nd Class).
1949–52	Collinson, Brian Morris	Mining (2nd Class).
1949–52	Davies, James Peter	Mining (2nd Class).
1949–52	Easteal, Charles Dennis	Metallurgy (2nd Class).
1949–52	Ebsworth, Piers Maurice	Mining (2nd Class).
Feb., 50 Feb., 52	Edwards, Richard Charles John ...	Mining Geology (2nd Class).
1949–52	Flatley, Peter	Metallurgy (2nd Class).
1949–52	Fulwell, Michael David	Metallurgy (2nd Class).
1949–52	Grainger, John Evans	Mining (2nd Class).
1948–52	Green, Edward Charles	Metallurgy (2nd Class).
1948–52	Griffiths, David	Mining (Pass).
1948–52	Hall, Philip Kenneth	Mining Geology (2nd Class).
1949–52	Holman, Ronald Herman Charles	Mining Geology (2nd Class).
1949–52	Honan, Brian Barry Ignatius ...	Mining (Aegrotat).
1949–52	Hunt, Timothy John	Mining (2nd Class).
1949–52	Jarvis, Paul	Mining (2nd Class).
1948–52	Jones, Leighton Warmington ...	Oil Technology (Pass).
1949–52	Lock, Maurice	Oil Technology (Pass).
1949–52	McKechnie, Alec Raymund ...	Metallurgy (Pass).
1949–52	O'Connor, Michael Palmer ...	Mining (2nd Class).
1948–52	Patrick, Alan Walter	Metallurgy (1st Class).
1949–52	Pearce, Richard Gerald Anthony	Metallurgy (2nd Class).
1948–52	Penstone, Michael Edward ...	Mining Geology (2nd Class).
1948–52	Phillips, William Garth Barrington	Mining (Pass).
1947–52	Pryke, Geoffrey Ernest	Oil Technology (Pass).
1949–52	Robinson, William Sandwith ...	Oil Technology (2nd Class).
1949–52	Rogans, David Fairfield	Mining (Pass).
1948–52	Sanders, Ian Alexander	Mining (Pass).
1949–52	Scott, Barry	Mining Geology (1st Class).
1949–52	Scriminger, Thomas Henry ...	Mining (Pass).

Session.	Name.	Department.
1945–46 1948–52	Stuart, Michael	Mining (Pass).
1948–52	Walker, Walter Buchanan Gordon	Mining Geology (2nd Class).
1948–52	White, John Frederick Cecil ...	Mining (2nd Class).
1949–52	Whitlock, Edward Frederick ...	Mining (2nd Class).

DIPLOMA OF ASSOCIATESHIP OF THE CITY AND GUILDS OF LONDON INSTITUTE (A.C.G.I.)

Session.	Name.	Department.
1949–52	Alexander, Alistair Alan	Electrical E.
1947–52	Allen, Charles David	Civil E.
1949–52	Allen, Graeme Philip	Civil E.
1949–52	Allsopp, Philip Anderson Desmond	Civil E.
1949–52	Andrews, Allan Peter	Civil E.
1949–52	Arregger, John Edward	Chemical E.
1949–52	Avner, David Alan	Mechanical E.
1949–52	Bagley, Frederick Charles	Aeronautical E.
1947–49 1950–52	Bailey, Derek Bruce	Civil E.
1949–52	Ball, David Richard	Electrical E.
1949–52	Bartley, David Arthur	Electrical E.
1949–52	Birkett, George William	Civil E.
1949–52	Blair, John Austin Incledon	Electrical E.
1949–52	Brealey, Alan Donald Robert	Electrical E.
1948–52	Bromley, Richard Bruce	Chemical E.
1949–52	Brook, Donald Guy	Civil E.
1949–52	Brown, Frederick	Aeronautical E.
1949–52	Brown, Kenneth Eaton	Mechanical E.
1949–52	Burdett, *Sir* Saville Aylmer, *Bart.*	Mechanical E.
1949–52	Caffarey, Anthony James	Chemical E.
1949–52	Camm, Kenneth	Electrical E.
1949–52	Carlile, Thomas Frederick	Electrical E.
1948–52	Chedzey, Clifford Stanley David	Mechanical E.
1949–52	Chettle, Peter Michael	Aeronautical E.
1949–52	Clapp, Richard Meyrick	Mechanical E.
1948–49 1950–52	Clemow, Christopher John	Electrical E.
1949–52	Cobb, Edward Clifford	Mechanical E.
1949–52	Collinge, Vincent Knight	Civil E.
1949–52	Collins, Robert John	Civil E.
1949–52	Conway, Arthur	Mechanical E.
1949–52	Coombe, John Grant Bolitho	Civil E.
1949–52	Cory, Brian John	Electrical E.
1949–52	Cowan, Donald Grosvenor	Chemical E.
1949–52	Curson, James Douglas	Civil E.
1949–52	Darracott, John Munville	Civil E.
1949–52	Dean, David Brian	Electrical E.
1949–52	Eastland, Graham Philip	Electrical E.
1949–52	Eldridge, Kenneth Percy	Civil E.
1949–52	El Tayib, Faroug	Electrical E.
1949–52	Etheridge, Geoffrey	Chemical E.
1949–52	Evans, John	Electrical E.

Session.	Name.	Department.
1949–52	Fadden, Arthur Frederick	Electrical E.
1945–46 1949–52	Farr, John William Frederick	Mechanical E.
1949–52	Fiander, David Charles	Electrical E.
1947–52	Fishwick, Geoffrey	Civil E.
1949–52	Flaxman, Edward Wasley	Civil E.
1949–52	Fothergill, Herbert Kenneth	Aeronautical E.
1947–52	Fredericks, James Albert	Electrical E.
1949–52	Fuglesang, Johan Christian	Electrical E.
1949–52	Gardner, David James	Civil E.
1949–52	Garrod, Denis John	Electrical E.
1949–52	Gear, David	Civil E.
1949–52	Gibbons, David John	Mechanical E.
1948–52	Gilbert, Thomas John	Chemical E.
1949–52	Glascodine, Richard Donald Samuel	Mechanical E
1949–52	Gleghorn, Peter	Electrical E.
1949–52	Goldhawk, Donald	Electrical E.
1949–52	Gollan, Graham Arthur	Civil E.
1949–52	Gray, Kenneth Roy	Chemical E.
1949–52	Green, Alan John	Mechanical E.
1949–52	Greenfield, David Challen	Electrical E.
1949–52	Grossman, Ernest Julius	Mechanical E.
1949–52	Hart, James Christopher	Mechanical E.
1949–52	Hately, Maurice Clifford	Electrical E.
1949–52	Havers, William Percival	Chemical E.
1949–52	Healy, Dennis	Electrical E.
1949–52	Hepner, Israel Leo	Chemical E.
1949–52	Herbert, John Richard	Mechanical E.
1949–52	Hinxman, Gerald	Civil E.
1949–52	Houghton, Peter Alan	Electrical E.
1949–52	Howorth, Jack Raymond	Electrical E.
1949–52	Hudson, Neil Jordan	Electrical E.
1949–52	James, Edwin Ernest	Mechanical E.
1949–52	James, James Leon	Chemical E.
1949–52	Jarvis, Roy Edward	Electrical E.
1949–52	Jewitt, Cyril	Electrical E.
1943–45 1948–52	Jordan, Robert William	Civil E.
1949–52	Kafarowski, Zygmunt	Civil E.
1949–52	Kearsey, Hugh Arthur	Chemical E.
1947–52	Kent, Gerald Thomas	Electrical E.
1949–52	Kent, Roy William	Civil E.
1949–52	Knight, Ronald George	Aeronautical E.
1949–52	Knill, Michael William	Civil E.
1949–52	Kohorn, Wolfgang Markus Adolf	Chemical E.
1949–52	Larner, Douglas Stanley	Electrical E.

Session.	Name.	Department.
1949–52	Last, John Derrick	Civil E.
1948–50 1951–52	Lee, John Lawrence	Mechanical E.
1949–52	Lemmer, William Andrew	Aeronautical E.
1949–52	Levy, Aronne	Mechanical E.
1949–52	Lindley, Peter Arnold	Mechanical E.
1949–52	Mabey, Dennis George	Aeronautical E.
1945–46 1949–52	McClelland, William Edward	Chemical E.
1949–52	McDaniel, John	Electrical E.
Oct. 43 May 44 1947-52	Macfie, Ronald Alastair Bute	Aeronautical E.
1949–52	McNelly, Malcolm John	Chemical E.
1949–52	Maplethorp, Serge Cyril	Civil E.
1949–52	Martin, John Stuart	Civil E.
1949–52	Mells, Roland Oliver	Mechanical E.
1949–52	Minton, Paul	Aeronautical E.
1945–47 1949–52	Moffat, Peter Alec Spencer	Civil E.
1949–52	Moore, Leslie Francis	Mechanical E.
1949–52	Morgan, Keith	Electrical E.
1949–52	Morphy, Arthur Richard Chaldecott	Mechanical E.
1945–46 1948–52	Morrison, Kennedy Lawrence	Mechanical E.
1949–52	Mossman, Stuart Alan	Mechanical E.
1947–50 1951–52	Murphy, Allan Michael	Civil E.
1949–52	Napthine, William Henry	Aeronautical E.
1949–52	Nelson, Rex Edward	Electrical E.
1949–52	Neukom, John Ulysses	Mechanical E.
1949–52	Newman, Ernest Clive	Civil E.
1949–52	Osborne, Paul Dallas Condé	Chemical E.
1949–52	Page, Edwin George	Civil E.
1945–46 1948–52	Peckham, David Ernest George	Mechanical E.
1949–52	Peters, Denis Arthur Haylock	Chemical E.
1949–52	Phillips, Robert Henry	Chemical E.
1949–52	Pilcher, Derek Gerald	Electrical E.
1949–52	Polack, Bernard McCarthy	Civil E.
1949–52	Rawicz-Szczerbo, Janusz	Electrical E.
1949–52	Rich, Paul Duguid	Chemical E.
1949–52	Schussheim, Michael	Mechanical E.
1949–52	Shaw, Peter Annesley	Electrical E.
1949–52	Simonson, John Richard	Mechanical E.
1949–52	Simpson, Alan	Civil E.

Session.	Name.	Department.
1945–46 1949–52	Skillman, John Michael	Civil E.
1949–52	Smith, Geoffrey Ernest	Civil E.
1948–52	Steele, Francis Howard	Electrical E.
1949–52	Stevens, Colin Bennett	Civil E.
1945–46 1948–52	Sturt, George Holford	Mechanical E. Electrical E.
1949–52	Sutcliffe, Jack	Mechanical E.
1949–52	Swanson, Sydney Alan Vasey	Civil E.
1949–52	Taylor, Leonard Edwin	Chemical E.
1949–52	Theobald, Brian James	Aeronautical E.
1949–52	Thomas, David	Aeronautical E.
1949–52	Toplis, Arthur Frederick	Chemical E.
1949–52	Towell, Gordon David	Electrical E.
1949–52	Versteegh, Arnold Jan	Chemical E.
1949–52	Ward, Derek Edwin	Mechanical E.
1944–46 1949–52	Warren, David Ian	Civil E.
1949–52	Waterfield, Anthony William	Electrical E.
1948–52	Whitfield, Samuel Jeremy Mackay	Chemical E.
1949–52	Wilkinson, Jeffrey	Civil E.
1949–52	Wyatt, Thomas Alan	Mechanical E.
1949–52	Young, David Patrick	

SCHOLARSHIPS, PRIZES AND MEDALS AWARDED TO COLLEGE STUDENTS

Baker Prize ... ... Slater, Charles Albert

Bennett H. Brough Medal and Prize ... Davies, James Peter

Bessemer Medal and Prize ... ... Half-share—Barleggs, Roy Ernest; Half-share—Patrick, Alan Walter

Bramwell Medals and Unwin Premiums Cobb, Edward Clifford; Swanson, Sydney Alan Vasey

Brinkworth Prize ... ... Gregory, Norman Lennox; Manning, Geoffrey

British Society of Mining Students' Prize. O'Connor, Michael Palmer

Charles Douglas Wheeler Prize ... Lawrie, Denys Stuart

Charleton Prize (1951 *Award*) ... Storrs, David Valentine

Clement Le Neve Foster Prize ... Cooray, Percival Gerald

Concrete Technology Bursaries ... Darracott, John Munville; Millar, Gordon Archibald Ian

Cullis Testimonial Fund ... ... Scott, Barry

De la Beche Medal ... ... Birch, John William

Edmund White Prizes for Organic Chemistry : (1) *Undergraduate* ... Golden, John Henry

(2) *Postgraduate* ... Webb, Reginald Francis

Ernest Edward Glorney Scholarship ... Half-share—Barleggs, Roy Ernest; Half-share—Patrick, Alan Walter

Faber Prize ... ... Taylor, Leonard Edwin

Finsbury Medal ... ... Mabey, Dennis George

Forbes Memorial Medal and Prize ... Half-share—Clayton, William Derek; Half-share—Southwood, Thomas Richard Edmund

Frank Hatton Prize ... ... Slater, Charles Albert

Governors' Prizes :—

In Mathematics ... ... Schiff, Bernard

Physics ... ... Manning, Geoffrey

Practical Chemistry ... ... Slater, Charles Albert

Mining ... ... O'Connor, Michael Palmer

Henrici Medal and Premium	Baker, Kenneth Everard
Hinchley Medal	James, James Leon
Hofmann Prize	Evans, Eustace Anthony
Huxley Memorial Medal and Prize ...	Mer, Cyril Leopold
Institute of Petroleum Prize (1951 *Award*).	Robinson, William Sandwith
John Samuel Scholarship	Lowe, John Alfred
Matthey Prize :	
1951 (Retrospective award)... ...	Catterall, John Ashley
1952	Hughes, James Ernest
Murchison Medal and Prize	Half-share—Crane, Frederick Albert Andrew Half-share—Hattersley, David Roberts
Perry Memorial Medal and Prize ...	Crane, Frederick Albert Andrew
Siemens Memorial Medal and Premium	Larner, Douglas Stanley
Tyndall Prize	Manning, Geoffrey
Unwin Medals and Premiums	Smith, Geoffrey Ernest Wyatt, Thomas Alan
Unwin Scholarships	Bergwerk, Walter Heller, Herbert Lefebvre, Arthur Henry
Watts Medal	Middleton, Gerard Viner